Radiological Health Data

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VOLUME IV, NUMBER 3

MARCH 1963

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Surveillance of gross beta activity in air and precipitation permits quick and sensitive detection of fission product activity fluctuation in the environment. Although this information alone does not allow evaluation of biological effects due to fallout, it forms the basis of alerting systems and can be used as a rough index to determine when and where more extensive monitoring of radioactivity in food, milk, and water may be indicated.

November 1962 gross beta concentrations are presented in the following reports from the Radiation Surveillance Network, 80th Meridian (West) Sampling Program, Canadian Radioactive Fallout Study Program, and the Mexican Radioactive Fallout Program. Because of differences in equipment and techniques the results of one network are not directly comparable with those of another. A study conducted by Lockhart and Patterson of the U.S. Naval Research Laboratory has determined intercalibration factors for comparing the results of three networks (*1*, *2*). Using these factors a 1.00 $\mu\mu c/m^3$ reading by the Canadian Air Monitoring Network would correspond to 0.65 $\mu\mu c/m^3$ by the Radiation Surveillance Network and 1.12 $\mu\mu c/m^3$ by the NRL 80th Meridian Network (*2*). These factors are subject to the uncertainty of air volume measurements and may not hold for very young fission products.

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(*1*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: *Intercalibration of Some Systems Employed in Monitoring Fission Products in the Atmosphere, NRL Report 5850*, Washington, D.C. (November 13, 1962).
(*2*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: Intercalibration of Some Air Monitoring Systems, *Radiological Health Data*, *3*:466–70, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (December 1962).

RADIATION SURVEILLANCE NETWORK
November 1962

Division of Radiological Health,
Public Health Service

During November 1962, the Radiation Surveillance Network (RSN) comprised 72 sampling stations distributed among the fifty States, Guam, and Puerto Rico. RSN sampling stations are manned predominantly by State Health Department personnel.

Air

Daily 24-hour air samples are collected by a high-volume air sampler with a 4-inch diameter carbon-loaded cellulose dust filter. Estimates of the beta activity of airborne particulates are derived by comparing portable survey meter count readings of these filters with readings taken from a known Sr^{90}–Y^{90} activity source. Counting is done 5 hours after collection to eliminate interference from naturally-occurring radon daughters. The Network's station operators maintain the daily national report by telephoning their field estimates to the Radi-

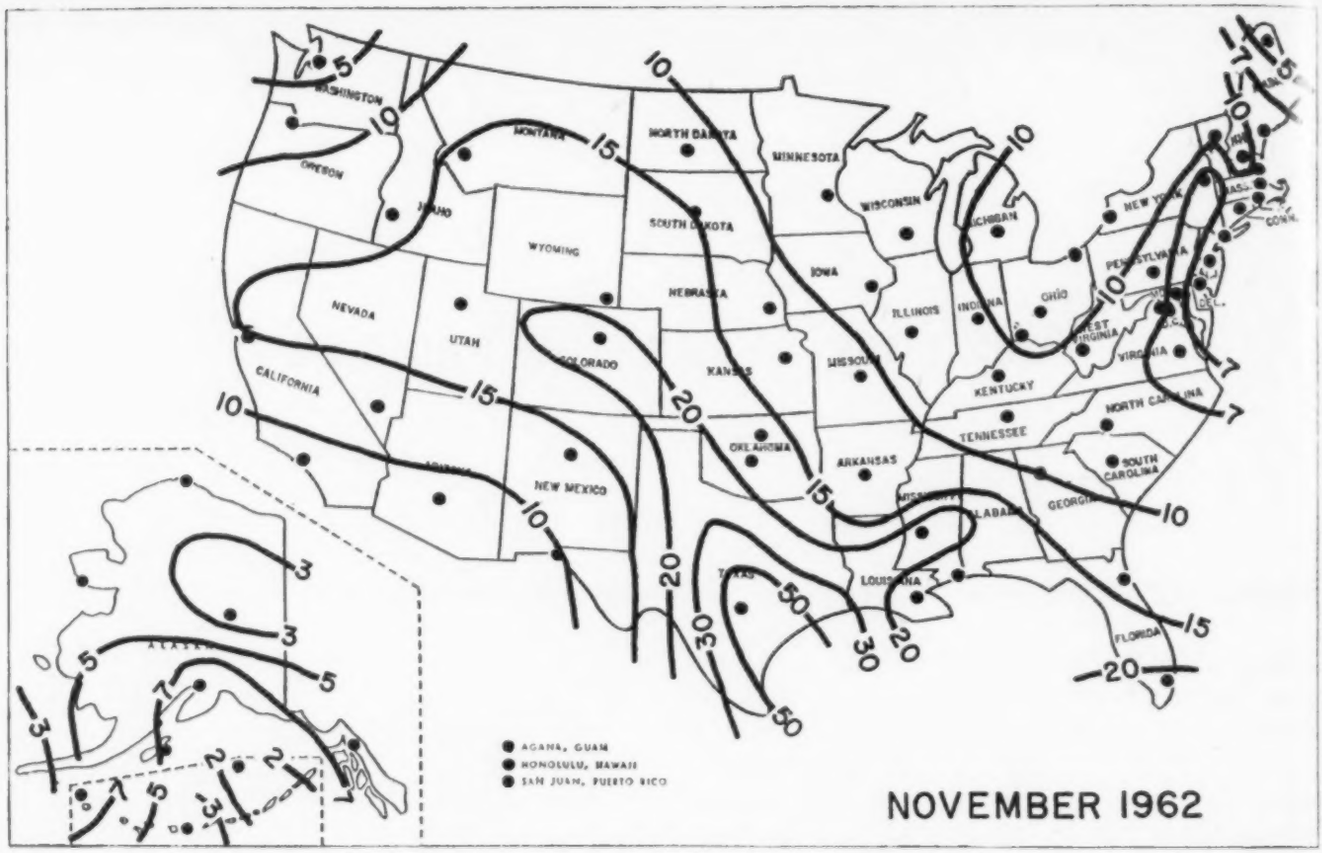

Figure 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS AND AVERAGE FISSION PRODUCT BETA CONCENTRATIONS IN AIR ($\mu\mu c/m^3$) NOVEMBER 1962

ation Surveillance Center, Division of Radiological Health, Washington, D.C.

The filters are then forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, for a more refined measurement using a thin-window gas-flow proportional counter. Each filter is counted at least 3 days after the end of the sampling period and re-counted 7 days later. The initial 3-day aging of the sample eliminates interference from naturally-occurring radon and thoron daughters. The two counts, separated by a 7-day interval, make possible the estimation of the age of fission products and extrapolation of the activity to the time of collection. The extrapolation is performed by using the Way-Wigner formula ($AT^{1.2} = \text{constant}$).*

Although gross beta concentration is usually presented without reference to age, it is apparent that fission product activity is more adequately described when the age parameter is also given. Studies on determining a meaningful monthly average age of fission products are now in progress.

The average fission-product beta concentrations in surface air during November 1962, as determined by laboratory analysis and extrapolated to the time of collection, are given in table 1 and presented by means of concentration contours in figure 1.

Precipitation

Continuous sampling for total precipitation is conducted at most stations on a daily basis using funnels with collection areas of 0.4 m^2. A 500-ml aliquot of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples. If the collected sample is between 200 and 500 ml, the entire sample is evaporated; if less than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made. November 1962 averages of gross beta activity in precipitation, expressed in micromicrocuries per liter

* In this expression, A is the activity and T is the time after fission product formation.

TABLE 1.—GROSS BETA ACTIVITY OF PARTICULATES IN AIR, RSN, NOVEMBER 1962

[Concentrations in $\mu\mu c/m^3$]

Station location	Number samples	Maximum	Minimum	Average [a]	Last profile in RHD
Alaska: Adak	29	8.0	1.3	3.8	Nov 62
Anchorage	30	25	1.3	7.2	Jul 62
Attu	30	23	1.7	8.8	Dec 62
Fairbanks	8	5.5	1.3	2.5	Aug 62
Juneau	23	48	0.14	6.3	Sep 62
Kodiak	29	40	<0.10	7.0	Oct 62
Nome	20	19	0.46	4.1	Feb 63
Point Barrow Isl	13	10	1.5	3.3	Mar 63
St Paul Island	28	4.6	<0.10	1.9	
Ariz: Phoenix	29	18	3.6	8.2	Aug 62
Ark: Little Rock	28	30	1.2	12	Sep 62
Calif: Berkeley	29	93	1.8	15	Sep 62
Los Angeles	19	19	3.5	9.1	Feb 63
Colo: Denver	28	166	2.1	21	Oct 62
Conn: Hartford	30	34	0.94	8.4	Sep 62
Del: Dover	17	50	2.3	9.2	
D.C: Washington	30	22	0.73	6.2	Mar 63
Fla: Jacksonville	30	42	3.6	14	Sep 62
Miami	29	69	3.4	22	Feb 63
Ga: Atlanta	27	50	0.66	10	Jul 62
Guam: Agana	—	—	—	—	Mar 63
Hawaii: Honolulu	29	7.2	0.42	2.7	Nov 62
Idaho: Boise	29	42	2.7	12	Dec 62
Ill: Springfield	30	20	0.64	8.3	Oct 62
Ind: Indianapolis	29	23	0.95	8.8	Jul 62
Iowa: Iowa City	29	29	1.2	8.7	Nov 62
Kans: Topeka	29	45	2.3	12	Jul 62
Ky: Frankfort	28	23	0.57	8.7	Mar 63
La: New Orleans	29	112	1.3	17	Nov 62
Maine: Augusta	26	41	0.30	9.5	Mar 63
Presque Isle	30	21	0.17	4.0	
Md: Baltimore	19	40	1.4	9.4	Sep 62
Rockville	14	29	2.2	9.6	
Mass: Lawrence	28	30	0.74	7.5	Aug 62
Winchester	27	42	1.9	11	
Mich: Lansing	30	48	0.89	11	Jul 61
Minn: Minneapolis	28	21	2.2	7.4	Mar 63
Miss: Jackson	26	203	1.2	24	Mar 63
Pascagoula	19	49	1.4	16	Nov 62
Mo: Jefferson City	29	36	1.3	11	Dec 62
Mont: Helena	29	40	3.1	16	Nov 62
Nebr: Lincoln	24	66	0.54	12	
Nev: Las Vegas	25	47	1.9	13	
N.H: Concord	19	47	0.44	11	
N.J: Trenton	29	30	0.51	9.3	Oct 62
N. Mex: Santa Fe	28	113	2.1	13	Dec 62
N. Y: Albany	28	19	0.89	6.9	Jul 62
Buffalo	29	41	0.56	11	
New York	13	24	2.3	9.4	Dec 62
N.C: Gastonia	30	22	1.6	9.5	Oct 62
N. Dak: Bismarck	29	46	1.2	12	Feb 63
Ohio: Cincinnati	18	32	1.2	12	Jul 60
Columbus	29	43	1.4	14	Feb 63
Painesville	30	48	0.97	11	
Okla: Oklahoma City	27	149	0.78	19	Jul 61
Ponca City	29	37	0.43	6.9	Oct 62
Ore: Portland	28	49	0.84	8.8	Oct 62
Pa: Harrisburg	15	19	1.1	6.6	Dec 62
P.R: San Juan	27	9.9	0.33	3.5	
R.I: Providence	29	32	0.84	9.9	Nov 62
S.C: Columbia	27	25	1.3	8.2	Dec 62
S. Dak: Pierre	30	66	0.46	15	Sep 62
Tenn: Nashville	14	22	2.6	9.7	Feb 63
Tex: Austin	30	575	0.37	54	Aug 62
El Paso	29	60	3.3	10	Feb 63
Utah: Salt Lake City	30	109	3.0	19	Jul 62
Vt: Barre	29	37	0.30	10	
Va: Richmond	29	24	0.41	6.8	Aug 62
Wash: Seattle	28	22	1.3	5.3	Jul 62
W. Va: Charleston	24	23	1.6	8.3	
Wis: Madison	29	39	0.69	9.7	Aug 62
Wyo: Cheyenne	29	186	1.5	16	Aug 62
Network average				10.8	

[a] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, NOVEMBER 1962

Station location		Average concentration ($\mu\mu c$/liter)	Total deposition ($m\mu c/m^2$)
Alaska:	Adak	*	*
	Anchorage	2,000	18
	Attu	*	*
	Fairbanks	3,200	2.0
	Juneau	5,400	570
	Kodiak	*	*
	Nome	*	*
	Point Barrow Isl	*	*
	St Paul Island	*	*
Ariz:	Phoenix	*	*
Ark:	Little Rock	3,400	230
Calif:	Berkeley	2,100	53
	Los Angeles	*	*
Colo:	Denver	930	5.9
Conn:	Hartford	2,100	150
Del:	Dover	*	*
D.C:	Washington	2,200	150
Fla:	Jacksonville	1,300	51
	Miami	1,500	94
Ga:	Atlanta	1,300	120
Guam:	Agana	*	*
Hawaii:	Honolulu	*	*
Idaho:	Boise	7,500	340
Ill:	Springfield	1,500	13
Ind:	Indianapolis	5,400	140
Iowa:	Iowa City	1,600	45
Kans:	Topeka	2,000	18
Ky:	Frankfort	2,300	120
La:	New Orleans	1,900	150
Maine:	Augusta	2,600	460
	Presque Isle	1,300	140
Md:	Baltimore	3,700	73
	Rockville	*	*
Mass:	Lawrence	1,800	190
	Winchester	2,000	220
Mich:	Lansing	5,600	47
Minn:	Minneapolis	3,500	34
Miss:	Jackson	2,400	74
	Pascagoula	480	2.4
Mo:	Jefferson City	2,900	48
Mont:	Helena	6,500	88
Nebr:	Lincoln	6,800	82
Nev:	Las Vegas	*	*
N.H:	Concord	*	*
N.J:	Trenton	900	16
N. Mex:	Santa Fe	1,500	54
N.Y:	Albany	3,700	200
	Buffalo	480	150
	New York	*	*
N.C:	Gastonia	530	64
N. Dak:	Bismarck	12,000	68
Ohio:	Cincinnati	*	*
	Columbus	2,100	130
	Painesville	4,400	320
Okla:	Oklahoma City	1,300	2.5
	Ponca City	4,700	150
Ore:	Portland	520	4.5
Pa:	Harrisburg	1,200	74
P.R:	San Juan	550	42
R.I:	Providence	1,800	200
S.C:	Columbia	690	87
S. Dak:	Pierre	*	*
Tenn:	Nashville	6,300	50
Tex:	Austin	11,000	370
	El Paso	5,700	17
Utah:	Salt Lake City	2,100	39
Vt:	Barre	4,500	340
Va:	Richmond	1,400	170
Wash:	Seattle	4,300	430
W. Va:	Charleston	2,600	260
Wis:	Madison	5,400	31
Wyo:	Cheyenne	1,800	20

* No evaporated sample received

($\mu\mu c$/liter) and millimicrocuries per square meter ($m\mu c/m^2$), are presented in table 2.

Profiles

Profiles of the monthly average fission product beta activity in airborne particulates for each RSN station covering the period of time from the formation of the network in 1956 to the end of 1960 were published in *RHD*, July 1961. Profiles of 7 stations, updated through November 1962, are shown in figure 2. An index giving the *RHD* issue having the most recent profile for each station is given in the last column of table 1.

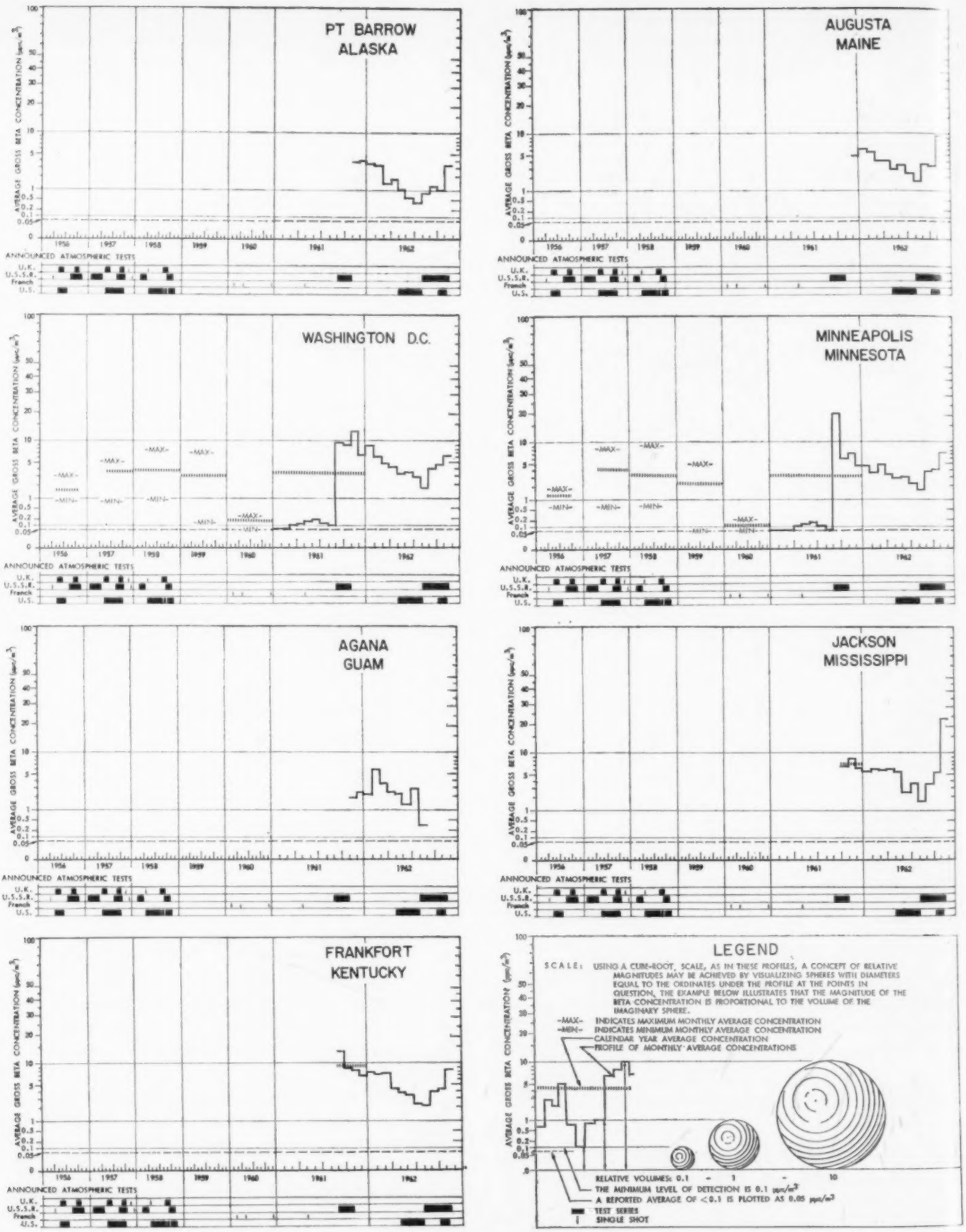

Figure 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR, RADIATION SURVEILLANCE NETWORK, 1956–NOVEMBER 1962

THE 80TH MERIDIAN (WEST) SAMPLING PROGRAM November 1962

U.S. Naval Research Laboratory

Radioactivity measurements of surface air samples collected at various sites (see figure 3) near the 80th Meridian (West) have been made since 1956 by the U.S. Naval Research Laboratory (NRL),* with the cooperation of interested agencies of the United States, Canada, Ecuador, Peru, Bolivia, and Chile, which collect the samples and forward them to NRL for analysis. Partial financial support of this program is provided by the Division of Biology and Medicine, U.S. Atomic Energy Commission.

The sampling procedure involves drawing air continuously for a 7-day period at a rate of approximately 1200 cubic meters per day through an 8-inch diameter, high-efficiency filter, using a positive-displacement blower. After the 7-day period, the filter is removed and forwarded to NRL for assay of gross beta activity. A minimum of 2 weeks after collection is allowed for decay of short-lived radionuclides. November 1962 data in table 3 are not extrapolated to time of collection.

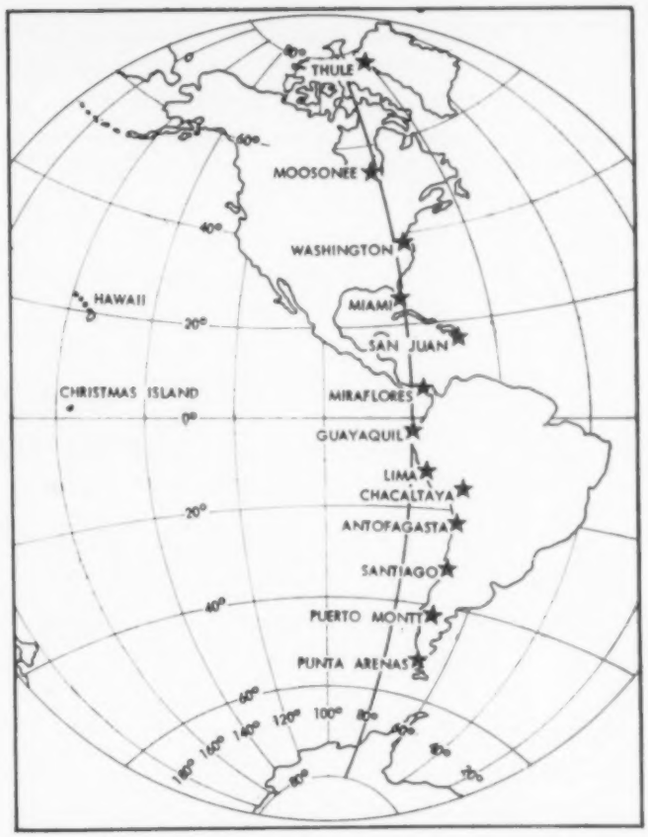

Figure 3.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

* *Editor's note:* Effective January 1, 1963, administration of the 80th Meridian (West) Sampling Program was turned over to the Health and Safety Laboratory, Division of Biology and Medicine, AEC, by the U.S. Naval Research Laboratory.

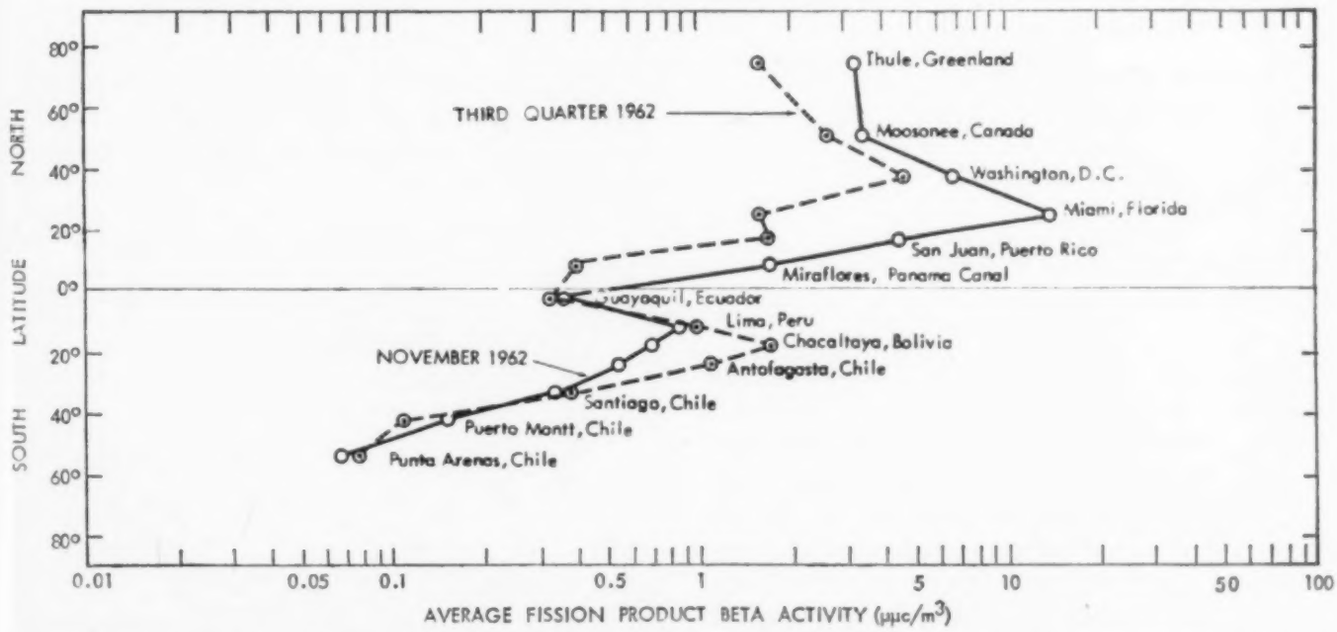

Figure 4.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENT OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (WEST), NOVEMBER 1962

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, NRL[a] NOVEMBER 1962

[Average concentrations in $\mu\mu c/m^3$]

November 1962	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador	Miraflores, Panama Canal Zone	San Juan, P.R.	Mauna Loa, Hawaii[c]	Miami, Florida	Washington, D.C.	Moosonee, Canada	Thule, Greenland
1 2 3 4 5	0.069	0.167	0.290	0.711	0.662	0.752	0.102	0.144	1.42	2.07	6.62	3.31	1.86	2.12
6 7 8 9 10 11 12	0.068	0.144	0.333	0.662	1.05	0.914	0.391	2.56	2.02	2.41	19.0	5.26	3.71	2.27
13 14 15 16 17 18 19	0.101	0.198	0.554	0.348	0.368	0.720	0.459	2.92	6.75	4.25	12.7	8.19	2.37	3.13
20 21 22 23 24 25 26	0.035	0.148	0.287	0.477	0.778	0.886	[b]—	0.909	6.08	8.64	18.4	4.72	2.96	3.41
27 28 29 30	0.050	0.126	0.327	0.477	0.468	—	—	2.03	5.18	5.26	8.73	14.9	6.98	5.00
Weighted average	0.066	0.159	0.366	0.526	0.684	0.824	0.340	1.78	4.39	4.64	14.0	6.80	3.35	3.08

[a] The average concentration determined from a given sample is placed at the center of a rectangle which indicates the length and dates of the sampling period. Station averages for the month were determined by weighting the sample average according to the number of days in the sampling period or that portion of the sampling period occurring in November 1962.

Dash indicates samples were not received.

[c] Mauna Loa data have been included for comparison with Chacaltaya, Bolivia. Both are high elevation stations (3400 and 5200 meters, respectively) and about equally distant north and south of the equator.

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

November 1962

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs. The 24 air and precipitation stations are located at airports (see figure 5), and the equipment is operated by meteorologists of the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in the Department's reports (*1–5*).

Figure 5.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

Precipitation

The amount of radioactive fallout being deposited on the ground is determined from measurements on material collected in special polythene lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. November 1962 precipitation data, including some radiochemical analyses, are presented in table 4.

Air

About 650 cubic meters of air are drawn through a high-efficiency 4-inch-diameter filter during a 24-hour period. Filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2-inch-diameter disk is removed from each filter and counted with a thin end-window Geiger flow counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are made on each filter to allow for the presence of natural activities and for the decay of short-lived fission products. The result is extrapolated to the end of the sampling period. Air data for November 1962 are presented in table 5.

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, NOVEMBER 1962

Station	Total beta activity		Deposition of specific radionuclides for selected samples[1,2] (mμc/m²)				
	μμc/liter	mμc/m²	Sr^{89}	Sr^{90}	Zr^{95}	Cs^{137}	Ba^{140}
Calgary	1,730	7.4	1.87	0.18	7.40	0.39	—
Chatham	2,390	275					
Coral Harbour	1,520	18					
Edmonton	7,170	69					
Fredericton	1,800	183					
Ft. Churchill	1,420	47					
Ft. William	3,450	92					
Goose Bay	1,160	134					
Inuvik	3,240	44					
Kapuskasing	1,810	82					
Montreal	4,440	183	13.9	0.43	26.6	0.58	26.5
Moosonee	1,960	93					
Ottawa	3,690	224					
Regina	11,700	69					
Resolute	7,690	391					
Saskatoon	5,210	68					
Shearwater	1,710	311	15.8	0.69	47.2	0.81	27.8
Torbay	888	203					
Toronto	1,730	111					
Vancouver	3,040	570	41.2	1.76	94.2	1.86	81.5
Whitehorse	2,050	46					
Windsor	2,120	103					
Winnipeg	1,650	90	8.06	0.42	15.1	0.51	14.4
Yellowknife	1,280	37					
Average	3,120	144					

[1] All values corrected for decay back to end of collection month.

[2] Values for strontium–90, cesium–137, and zirconium–95 do not include the activities of their daughter isotopes, yttrium–90, barium–137, and niobium–95.

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR, RFSP, NOVEMBER 1962

[Average concentrations in $\mu\mu c/m^3$]

Station	Number of Samples	Maximum	Minimum	Average
Calgary	19	105.0	1.8	25.8
Chatham	29	37.0	0.9	9.4
Coral Harbor	29	57.0	0.4	7.6
Edmonton	30	46.0	0.5	13.6
Ft. Churchill	30	12.3	0.8	5.3
Ft. William	29	84.0	1.8	16.5
Fredericton	30	43.0	0.4	10.5
Goose Bay	30	23.0	0.2	6.1
Inuvik	30	19.0	2.8	7.0
Kapuskasing	19	17.0	2.7	7.5
Montreal	29	38.0	0.5	11.7
Moosonee	27	37.0	0.9	7.5
Ottawa	29	59.0	2.5	15.3
Regina	30	73.0	2.1	17.7
Resolute	4	33.0	0.8	11.1
Saskatoon	30	65.0	0.9	13.9
Shearwater	29	34.0	0.0	11.3
Torbay	29	31.0	0.2	6.3
Toronto	30	47.0	0.9	14.1
Vancouver	29	73.0	2.0	13.7
Whitehorse	29	83.0	2.2	13.5
Windsor	30	60.5	3.1	17.0
Winnipeg	30	62.0	0.9	12.7
Yellowknife	30	13.3	2.2	6.2
Average				11.7

Recent coverage in *Radiological Health Data*:

Period	Issue
First quarter 1961	*December 1961*
Second quarter 1961	*February 1962*
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*
Second and third quarters 1962	*January 1963*
October 1962	*February 1963*

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MEXICAN RADIOACTIVE FALLOUT PROGRAM

October and November 1962

Radiation Protection Program, National Commission of Nuclear Energy, Mexico

The Radiation Surveillance Network of Mexico was established by the "Comisión Nacional de Energía Nuclear" (C N E N) through its Radiological Protection Program (RPP) in 1961 to provide a means for determining increased levels of radioactivity in air and precipitation due to fallout from nuclear tests.

Prior to the establishment of the network, two pilot sampling stations were set up in México, D. F. (Mexico City) and San Luis Potosí to aid in the selection of equipment and sampling sites. Since April 1962 the network has been expanded to twelve stations, ten of which were in operation by the end of November 1962 (see figure 6).

Figure 6.—FALLOUT NETWORK SAMPLING STATIONS IN MEXICO

Seven of the ten sampling stations are located at airports and are operated by airline personnel. The remaining three stations are located at Mexico City, Merida, and Veracruz. Staff members of the RPP operate the station at Mexico City, while the other two stations are manned by members of the "Centro de Previsión del Golfo de México."

Sampling

The sampling procedure involves drawing air 24 hours a day, 3 or 4 days a week at the rate of approximately 1,200 cubic meters per day, through a high-efficiency glass fiber filter, 6" × 8", using high volume samplers. After each 24-hour period the filter is removed and forwarded via airmail to the "Laboratorio de Desechos Radiactivos," CNEN, in Mexico City for assay of gross beta activity. A minimum of 3 or 4 days after collection is allowed for decay of radon and thoron daughters. Data are not extrapolated to time of collection.

The maximum, minimum, and average fission product beta concentrations in surface air during October and November 1962 are presented in table 6.

TABLE 6.—GROSS BETA ACTIVITY OF AIRBORNE PARTICULATES, MEXICO, OCTOBER–NOVEMBER 1962

[Concentrations in $\mu\mu c/m^3$]

Month	Station	Number	Maximum	Minimum	Average
October	Acapulco	4	1.9	0.1	0.7
	Ciudad Juárez	8	34.5	2.7	15.0
	La Paz	7	12.1	1.9	5.6
	Mérida	13	8.1	0.1	2.9
	México, D.F.	8	0.6	0.1	0.3
	San Luis Potosí	11	6.0	0.1	2.0
	Torreón	10	8.5	0.2	1.9
	Veracruz	13	12.0	0.1	4.6
	Guadalajara	9	2.6	0.1	0.6
November	Ciudad Juárez	7	25.4	4.9	13.4
	Guadalajara	12	13.6	1.6	5.9
	La Paz	7	12.3	1.7	4.2
	Mérida	10	94.2	2.1	20.7
	México, D.F.	8	36.3	0.6	9.6
	San Luis Potosí	12	31.4	0.7	9.9
	Torreon	8	35.7	3.0	17.4
	Veracruz	12	57.5	3.8	20.3
October-November Average					7.9

Meteorology of Airborne Fission Product Radioactivity in the Mexican Republic[1]

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In this report, categories and types of meteorological patterns prevalent in the Mexican Republic are reviewed and compared with particulate fission product gross beta activity in surface air. The meteorological analysis was based on five-year records of surface and higher altitude winds[2] (700 and 500 millibars) and on the classification proposed by Mosiño (*1*) for the patterns of atmospheric circulation over the Mexican Republic.

Meterologic Configuration

The Mexican Republic is situated in the tropical and extratropical zones (14–33° N). However, because of the position of mountain formations (figure 1), trade winds prevail over the country during some periods but westerly winds coming from temperate latitudes are also observed.

In order to analyze the prevalent weather patterns, Mexican meteorologists have proposed, on the basis of surface weather mapping, three major categories of atmospheric circulation:

1. Cyclonic types
2. Anticyclonic types
3. "Norte" incursions

These categories are analyzed as follows.

[1] Summarized from the paper by I. G. Galindo Estrada, "The Meteorology of the Mexican Republic and its Relation to the Program of Radiologic Protection," (9 references), presented at the Fourth Inter-American Symposium on the Peaceful Application of Nuclear Energy, April 1962, Mexico City, Mexico.

[2] Data collected and analyzed by Radio Aeronautica Mexicana, S.A. (RAMSA) and the Servicio Meteorológica Mexicano.

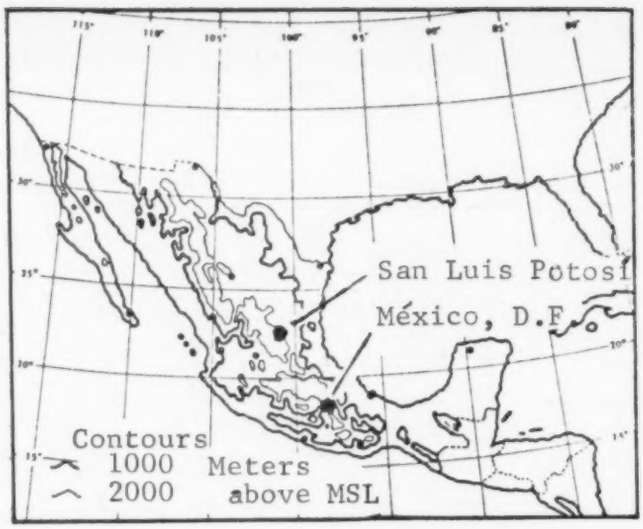

Figure 1.—TOPOGRAPHY OF MEXICO

Cyclonic Types

Some of these low pressure areas (counterclockwise motion) are of tropical origin, following an east to west direction from the Caribbean Sea. They may or may not have an incipient frontal wave (figure 2), with great cloudy masses that eventually precipitate along the frontal zone, washing the atmosphere and carrying to the earth surface airborne particles (washout). These patterns arise more frequently during the winter and spring (January to June).

Another tropical cyclonic pattern is observed during the summer (figure 3), a low pressure area over the Gulf of Mexico affecting the northern portion of the Mexican territory.

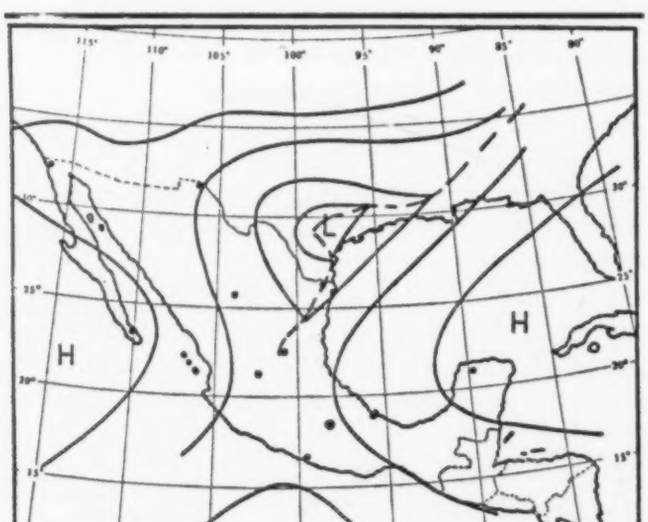

Figure 2.—WINTER AND SPRING CYCLONE

The continental portion of the country receive a low pressure pattern, called the leewar mountain trough (figure 4), originating on th eastern side of the Rocky Mountains and th Sierra Madre Oriental. Finally a depression a 700 millibars may occur over the plateau regio as is evidenced by the surface low shown i figure 5.

Anticyclonic Types

These are high pressure areas characterize by moderate central winds variable in direction and generally accompanied by good weather. They are related to the presence of the trade winds over the Gulf of Mexico, with paths approximately perpendicular to the main moun-

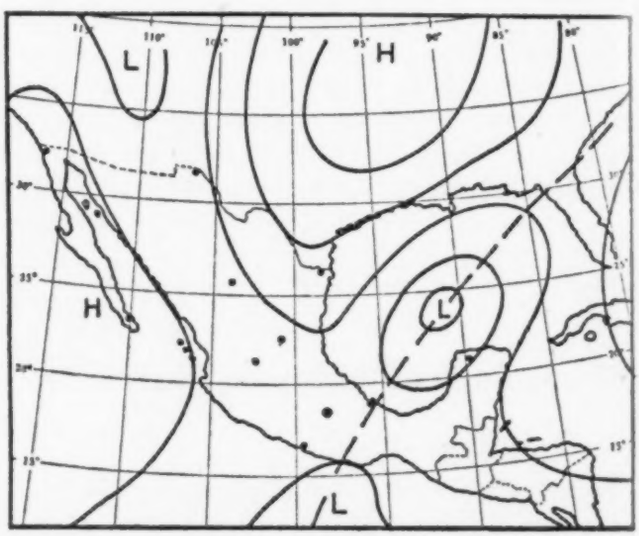

Figure 3.—TROPICAL SUMMER CYCLONE

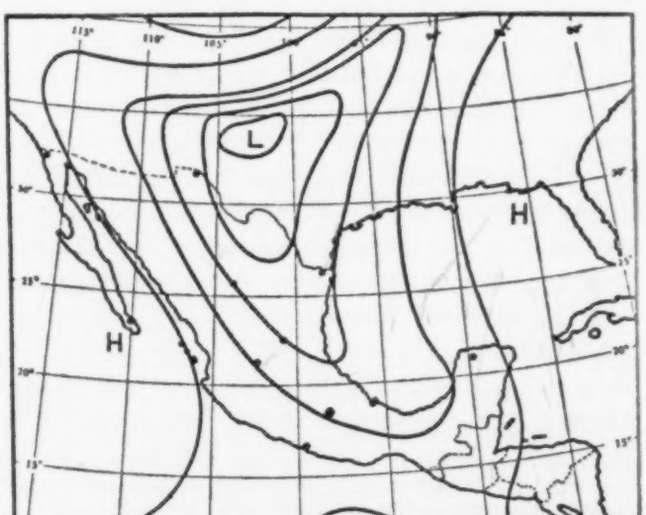

Figure 4.—LEEWARD MOUNTAIN TROUGH

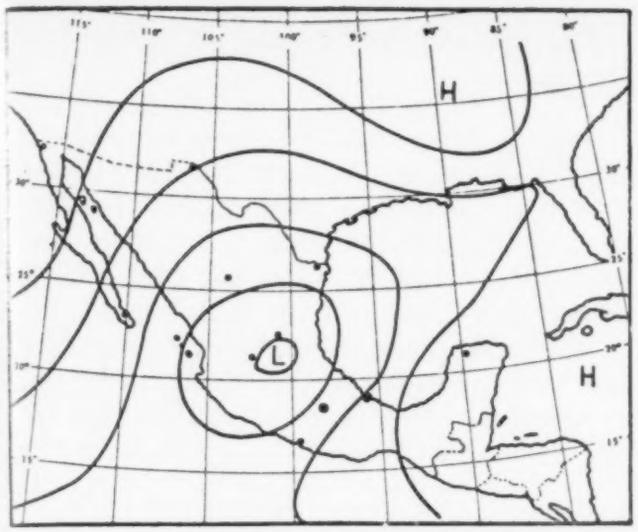

Figure 5.—PLATEAU DEPRESSION

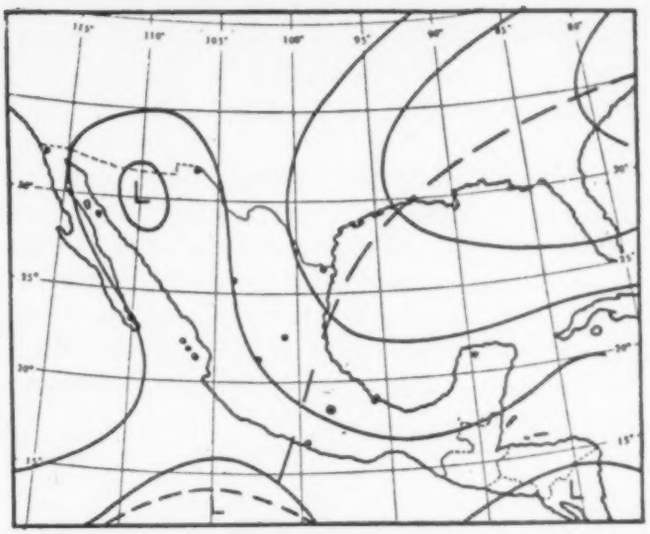

Figure 7.—ANTICYCLONE CENTERED OVER THE EAST COAST, UNITED STATES

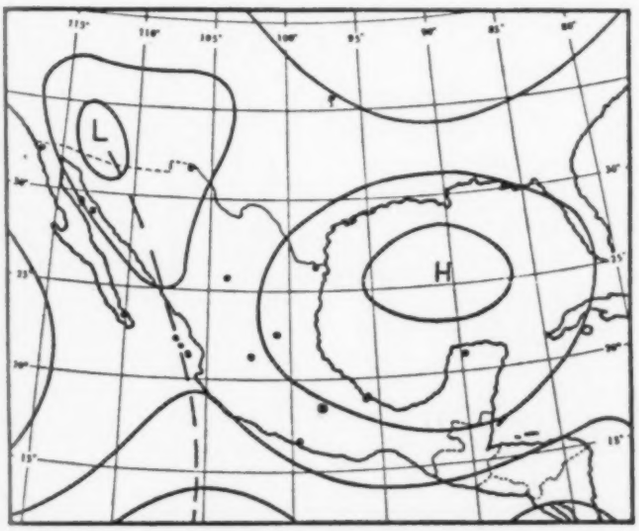

Figure 6.—ANTICYCLONE CENTERED OVER THE GULF OF MEXICO

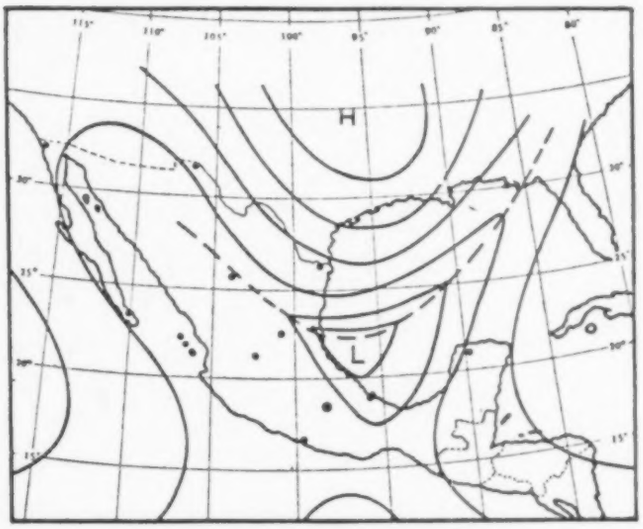

Figure 8.—INCURSION OF POLAR CONTINENTAL AIR

tain chains. Their frequency increases during summer months (July to September) (figure 6 and 7).

"Norte" Incursions

These are incursions of modified polar continental air over the Gulf of Mexico. They reach Mexican territory from the northeastern portion of the Gulf and affect the coastal plains and the northern zone of the country, touching Veracruz and then dissipating over deep sea. These incursions are sometimes so extensive that they involve the total area of the Gulf and also the Peninsula of Yucatan (figures 8 and 9). These high pressure areas following the cold front originate over the south part of the

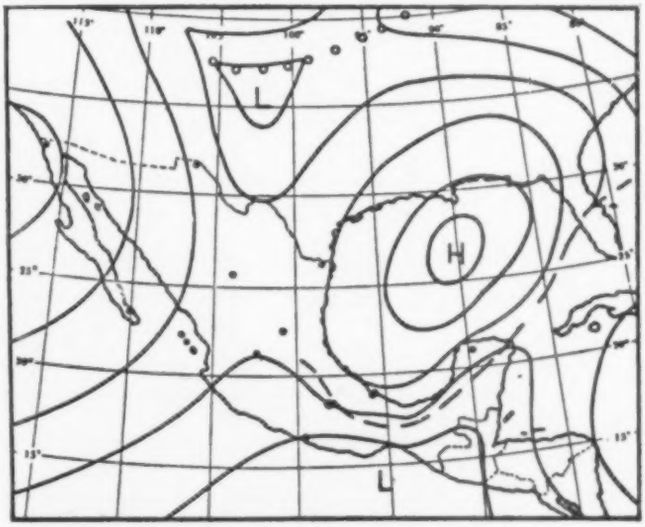

Figure 9.—EXTENSIVE INCURSION OF POLAR AIR

United States and sometimes over higher latitudes (central portion of the United States). They occur more frequently during the winter months November to January and the transitional seasons. The "Nortes" are characterized by strong northerly surface winds over the main body of the Gulf. Hurricane gusts blowing southerly from Veracruz through the Isthmus of Tehuantepec are sometimes also present.

A study of the meteorologic patterns discussed above may prove to be an important aid in predicting the paths of debris clouds over the country.

Relationship between the Prevailing Synoptic Situations and the Profiles of Gross Radioactivity

During the period of observation, the Comisión Nacional de Energía Nuclear (CNEN) had two monitoring stations, one located in Mexico City and the other in San Luis Potosí, both functioning since October 1961 (*2*). Figure 10 shows particulate beta concentrations in air during 6 months at each station (September 1961–February 1962). Table 1 shows the frequency of the described meterologic cate-

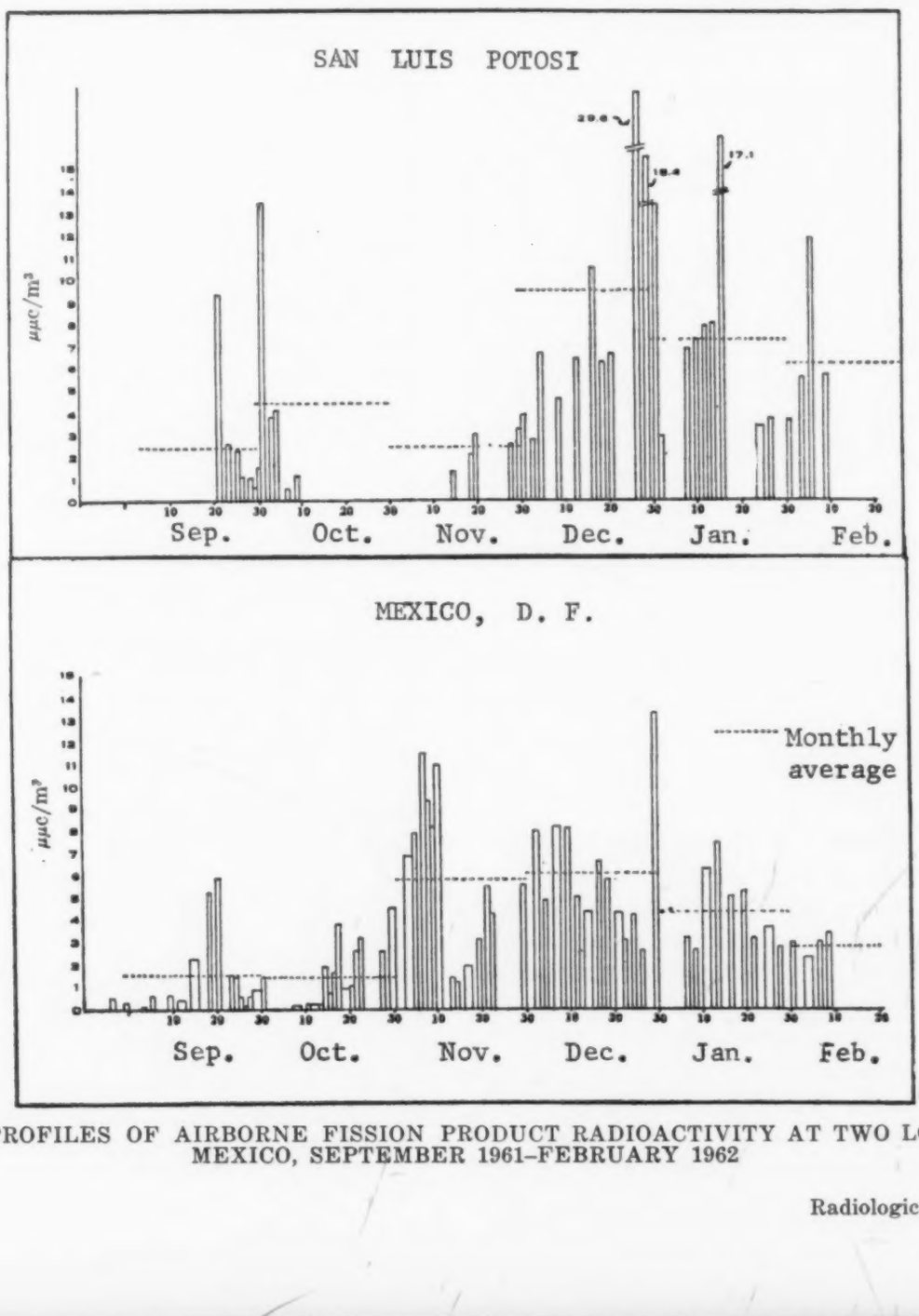

Figure 10.—PROFILES OF AIRBORNE FISSION PRODUCT RADIOACTIVITY AT TWO LOCATIONS IN MEXICO, SEPTEMBER 1961–FEBRUARY 1962

TABLE 1.—RELATIVE FREQUENCY OF PREVALENT WEATHER PATTERNS AND PROFILES OF RADIOACTIVITY IN THE ATMOSPHERE AT TWO LOCATIONS IN MEXICO, OCTOBER 1961—MARCH 9, 1962

[Concentrations in $\mu\mu c/m^3$]

Station	Prevalent weather patterns		Frequency	Concentration	
	Category	Type		Minimum	Maximum
Mexico City	Cyclonic types	1	5	0.13	3.43
		2	8	0.11	7.54
		3	7	0.10	2.80
		4	7	0.27	5.29
		5	1	0.37	0.37
			—		
		1–5	28 (39%)	0.10	7.54
	Anticyclonic types	6	5	0.64	6.90
		7	6	0.62	8.10
			—		
		6, 7	11 (15%)	0.62	8.10
	"Norte" incursions	8	18	0.16	13.49
		9	5	0.01	5.47
		10	10	0.08	13.47
			—		
		8–10	33 (46%)	0.01	13.49
San Luis Potosi	Cyclonic types	1	2	2.93	4.69
		2	3	0.33	6.10
		3	7	0.34	5.60
		4	3	0.61	3.29
		5	0	—	—
			—		
		1–5	15 (35%)	0.33	6.10
	Anticyclonic types	6	6	2.75	10.76
		7	4	1.19	6.22
			—		
		6, 7	10 (23%)	1.19	10.76
	"Norte" incursions	8	8	3.83	17.10
		9	4	2.84	29.64
		10	6	0.62	18.43
			—		
		8–10	18 (42%)	0.62	29.64

gories and pattern types during the period of study. It can be observed in both figures that the major concentrations of radioactivity were recorded during the winter (December to February). These peaks correspond fundamentally to "Norte" incursions. This might be expected in view of the fact that the announced U.S.S.R. nuclear detonations occurred in the north temperate and polar zones and the U.S. underground tests occurred in Nevada.

REFERENCES

(1) Mosiño, P.: Una Clasificacion de las Configuraciones del Flujo Aéreo en la República Mexicana, *Rev. de Ing. Hid. en Méx.*, *12*:2 (1958).

(2) National Commission of Nuclear Energy: Mexican Radioactive Fallout Program, October 1961–September 1962, *Radiological Health Data*, *3*:68–9 (February 1963).

SECTION II.—FOOD

Editor's note: There are two necessary steps in determining the dietary intake of radionuclides by a population. First, reliable data on the quantity of food items consumed must be obtained. Secondly, the radionuclide concentrations in these foods must be determined. This article contains recent consumption data for selected food items and includes examples of how the dietary intake of radionuclides may be calculated from such data.

Consumption of Selected Food Items in U.S. Households

July 1962

Bureau of the Census, Department of Commerce, and
Division of Radiological Health, Public Health Service

The following data cover the five food items included in the methodological survey conducted by the Bureau of the Census in July 1962 on behalf of the Public Health Service. The National Food Consumption Survey is a part of the Quarterly Household Survey conducted during the first two weeks of each quarter (July, October, January, and April). This survey covers a representative sample of the United States population to provide estimates of the amounts and kinds of foods consumed according to various personal and demographic characteristics and is jointly supported by the Division of Radiological Health (DRH), and the Heart Disease Control Program (HDCP), Division of Chronic Diseases of the Public Health Service.

The program was designed initially to develop the methods and procedures for the collection of data related to individual con-

Figure 1.—CENSUS REGIONS OF THE U.S.

umption of selected food items. In subsequent months similar information will be gathered on additional selected food items and the components of the total diet.

Design of Survey

In July, the Food Consumption Survey was conducted in every State and the District of Columbia. This sample contained a total of approximately 11,500 housing units (both occupied and vacant) and completed interviews were obtained in approximately 8,900 of these, containing about 28,000 persons. The January 1963 issue of *Radiological Health Data* contains a detailed discussion of the survey.

One limitation of the procedure was that it was not feasible (because of other commitments in the Census survey) to randomize the interviews by day of the week. To the extent that consumption patterns vary significantly by day of the week, additional errors may be introduced. The figures in the tables are based only on the results of the personal interviews—both the three-day recall and the one-day recall; final results of the diary approach are not as yet available. Examination of preliminary data obtained by diary, however, indicates no substantial differences.

Results and Discussion

While no conclusions may be reached about total milk consumption as these data are limited to consumption "at home," the mean values by age in table 1 indicate that males consume more milk than females in each age group (see January 1963 issue of *RHD* for percentage distribution of the population by milk consumption categories). This observation is also true for white bread and beef as indicated in tables 2 and 3. The distribution of the population shown in tables 2 through 5 indicates a relatively high percentage of no consumption on an average day during the period. While the survey itself does not provide answers to questions that might be raised about this point, it should be recognized that this may be explained by consumption taking place "away from home," and the many substitutes available for the specific items in the survey.

Tables 6 through 10 show both the distribution of the population by consumption categories and region of the country (see figure 1) and mean values for the same five food items. In general, the Southern region showed the lowest mean values for these particular items with the Northeastern region indicating the highest consumption.

TABLE 1.—AVERAGE DAILY "AT HOME" CONSUMPTION OF WHOLE MILK BY SEX AND AGE, JULY 1962 SURVEY

Age	Male		Female	
	Number of observations	Mean (fluid ounces)	Number of observations	Mean (fluid ounces)
All ages	32,012	11.7	33,568	8.5
Under 1	713	17.8	747	16.2
1–4	3,073	17.9	2,890	17.0
5–9	3,744	16.2	3,536	15.1
0–14	3,577	17.2	3,399	12.9
5–19	2,592	17.2	2,661	9.9
0–24	1,678	11.9	1,984	7.2
5–29	1,614	9.9	1,807	6.5
0–34	1,976	8.9	2,094	5.6
5–44	4,233	8.2	4,674	5.4
5–54	3,567	7.7	3,695	5.2
5–64	2,584	8.1	2,840	5.7
5+	2,661	8.3	3,241	6.5

Use in Radioactivity Intake Estimates

Plans are to combine food consumption estimates obtained from the survey with radionuclide concentration data produced by the Division of Radiological Health's National Dietary Assessment Program and from these to calculate estimates of radionuclide intake from the diet. These data will provide an empirical basis for comparisons with appropriate radiation protection guides on intake of radioactive materials. The program is also designed to determine the feasibility of using an "indicator food list" for the surveillance and assessment of radionuclide intake.

It should be noted that the data reported below are limited to "at home" consumption as reported in the July test. This, of course, precludes their use as a basis for estimating total radiation intake from the consumption of these items. The January 1963 Quarterly Household Survey, which covered ten food items, also included "away from home" consumption for the first time. Since the program objective is to produce dietary radionuclide intake estimates when complete consumption data are available, the following examples may be of interest.

In general, the procedure is to multiply mean

consumption estimates by population-weighted radionuclide concentrations to obtain intake estimates. If the "at home" figure of 14.4 ounces shown in table 6 as the average daily milk consumption for males in the Northeast region for the first two weeks of July 1962 was the total consumption estimate, and if the population-weighted mean value of 23.4 μμc of iodine–131/liter of milk during this period was representative of the concentration of this radionuclide for the same population group, by converting the 14.4 ounces to 0.4258 liters and multiplying by 23.4 μμc/liter, an estimated intake of 10.0 μμc/day is obtained as the estimated average daily intake of iodine–131 from milk for this population group in this region for the stated period. The same approach will be used for other radionuclides such as strontium–90 where, for example, if the "at home" estimate of 6.9 fluid ounces shown in table 6 was the total average daily consumption of milk for females in the Southern region during the first two weeks of July 1962, and the population-weighted strontium–90 concentration of 20.1 μμc/liter of milk was representative of this radionuclide in the milk consumed by this population, then by converting the 6.9 ounces to 0.2040 liters, and multiplying it by 20.1 μμc/liter, an estimated average daily intake of 4.1 μμc/day of strontium–90 from milk would be obtained for this population group in this region for the stated period. Future issues of *RHD* will contain radionuclide intake data arrived at by the procedure illustrated above.

TABLE 2.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHITE BREAD BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (slices)							Mean (slices)
		None	1–2	3–4	5–6	7–8	9–10	11+	
Male									
All ages	32,042	31.2	21.4	21.2	13.5	6.5	3.3	2.8	3.1
Under 1	711	87.3	9.8	2.0	0.4	0.4	0.2	—	0.3
1–4	3,075	28.8	39.5	21.1	7.0	2.3	0.7	0.6	1.5
5–9	3,747	23.3	25.4	27.6	14.5	5.9	2.0	1.3	2.6
10–14	3,580	26.0	17.9	21.8	15.9	8.0	5.0	5.6	3.9
15–19	2,596	29.7	15.8	17.9	16.9	8.6	5.5	5.6	3.9
20–24	1,680	31.7	14.5	19.2	15.8	8.5	4.5	5.9	3.8
25–29	1,615	35.1	15.9	19.7	13.1	8.8	4.2	3.3	3.2
30–34	1,978	29.0	19.4	20.6	14.0	9.1	4.2	3.9	3.4
35–44	4,239	30.6	20.2	20.7	14.3	7.4	4.0	2.9	3.2
45–54	3,568	32.1	20.6	19.9	14.4	7.2	3.7	2.1	3.1
55–64	2,593	35.2	18.5	21.5	12.8	6.4	3.8	1.7	2.9
65+	2,660	33.6	23.6	24.7	13.6	2.7	0.7	1.2	2.5
Female									
All ages	33,597	34.3	30.0	22.7	8.9	2.6	0.9	0.7	2.1
Under 1	747	79.9	16.2	2.3	1.3	—	0.3	—	0.4
1–4	2,890	30.5	39.2	20.6	7.8	1.1	0.4	0.2	1.2
5–9	3,541	24.9	27.9	28.8	11.8	4.3	1.3	1.0	2.1
10–14	3,403	28.3	23.3	25.2	13.3	5.2	2.1	2.5	2.6
15–19	2,662	35.2	26.4	21.0	10.4	4.2	1.7	1.0	2.4
20–24	1,987	34.7	28.6	22.4	10.0	2.8	1.0	0.6	2.2
25–29	1,814	31.8	29.7	25.0	9.9	2.2	1.2	—	2.2
30–34	2,099	30.0	31.6	25.0	9.3	2.6	0.8	0.7	2.4
35–44	4,678	33.6	32.0	23.3	8.1	2.3	0.3	0.3	2.0
45–54	3,698	37.7	31.2	20.9	7.0	2.1	0.6	0.5	1.9
55–64	2,841	41.8	31.2	19.4	5.8	1.2	0.2	0.3	1.7
65+	3,237	36.8	31.3	23.5	6.7	1.0	0.4	0.2	1.8

TABLE 3.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF BEEF BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (ounces)										Mean (ounces)
		None	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	17+	
Male												
All ages	32013	66.7	2.9	8.2	6.1	7.8	2.4	2.5	0.6	1.8	1.0	2.4
Under 1	710	94.7	2.9	1.2	0.4	0.7	0.2	—	—	—	—	0.2
1–4	3070	68.0	12.2	13.3	3.7	1.7	0.7	0.2	0.1	0.1	—	0.9
5–9	3738	65.1	5.0	15.6	7.3	4.6	1.0	0.8	0.2	0.3	—	1.6
10–14	3577	63.4	2.9	11.0	9.1	7.0	2.4	2.2	0.8	0.8	0.4	2.3
15–19	2592	66.0	1.3	6.2	8.5	7.7	3.1	2.8	0.8	2.1	1.5	2.8
20–24	1677	67.3	0.9	5.2	5.5	9.0	3.4	3.3	0.7	2.5	2.3	2.9
25–29	1611	70.6	0.8	3.7	3.6	9.5	2.6	3.0	0.9	2.8	2.4	2.9
30–34	1972	65.0	1.0	4.2	5.7	10.8	3.1	3.9	1.2	3.3	1.9	3.2
35–44	4247	64.8	1.1	5.9	6.3	9.8	3.1	3.9	0.8	2.5	1.8	3.1
45–54	3568	65.6	0.9	5.5	6.1	9.9	2.9	3.9	0.7	3.1	1.4	3.0
55–64	2589	66.6	1.3	6.2	4.8	10.5	3.5	3.2	0.5	2.5	1.1	2.8
65+	2662	68.9	1.5	8.1	5.6	9.0	2.2	2.4	0.3	1.7	0.3	2.3
Female												
All ages	33573	67.4	3.7	11.6	6.8	6.3	1.4	1.1	0.3	0.9	0.3	1.9
Under 1	743	94.4	3.1	1.3	0.7	0.5	—	—	—	—	—	0.2
1–4	2891	68.3	12.9	13.5	3.6	1.1	0.4	—	—	—	—	0.7
5–9	3537	66.0	6.2	17.0	5.8	3.0	1.1	0.6	0.2	0.1	—	1.1
10–14	3391	67.7	2.7	12.5	8.4	5.2	1.5	1.2	0.2	0.4	0.2	1.6
15–19	2665	67.7	2.8	10.1	7.6	7.2	1.8	1.1	0.4	1.2	0.2	2.0
20–24	1985	66.9	1.6	10.1	8.2	7.1	1.9	2.2	0.2	1.3	0.4	2.2
25–29	1812	67.5	1.9	9.1	7.9	7.8	1.9	2.0	0.4	0.9	0.4	2.2
30–34	2097	65.2	2.0	10.9	8.1	7.6	1.8	2.0	0.4	1.3	0.6	2.4
35–44	4673	64.1	2.5	11.5	8.1	8.1	1.9	1.7	0.5	1.2	0.4	2.3
45–54	3695	64.3	2.0	10.3	8.0	8.9	1.9	2.3	0.4	1.4	0.4	2.5
55–64	2842	70.1	1.7	10.7	5.3	8.4	1.4	0.9	0.4	1.0	0.1	1.9
65+	3241	68.5	3.2	12.1	6.1	7.0	0.8	1.0	0.1	0.9	0.2	1.9

TABLE 4.—PERCENTAGE DISTRIBUTION "AT HOME" DAILY CONSUMPTION OF LETTUCE BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (ounces)							Mean (ounces)
		None	1	2	3	4	5–8	9+	
Male									
All ages	32022	72.9	5.7	9.5	3.4	5.7	2.3	0.5	0.8
Under 1	710	98.4	0.4	0.3	0.3	—	0.5	0.2	0.1
1–4	3071	83.3	6.9	5.9	1.8	1.3	0.6	0.2	0.3
5–9	3741	76.5	8.6	9.2	2.6	2.1	0.8	0.3	0.4
10–14	3578	72.8	7.3	10.2	4.1	3.5	2.0	0.3	0.7
15–19	2594	71.3	5.5	11.9	4.7	4.4	1.9	0.3	0.8
20–24	1679	73.7	4.3	8.3	4.6	5.8	2.8	0.5	0.9
25–29	1614	68.8	5.1	9.2	3.3	8.7	4.0	0.8	1.1
30–34	1975	67.3	4.8	11.3	3.9	8.9	3.3	0.6	1.1
35–44	4241	66.9	6.1	10.8	3.9	8.8	3.2	0.4	1.0
45–54	3569	69.0	5.1	10.7	3.8	8.1	2.6	0.7	1.0
55–64	2593	70.4	3.8	9.2	3.6	9.1	3.1	0.9	1.0
65+	2657	74.0	4.2	9.3	2.3	5.9	3.2	1.1	0.9
Female									
All ages	33588	72.1	6.1	10.5	3.2	5.6	2.1	0.4	0.8
Under 1	748	97.8	0.7	0.7	0.3	0.1	0.1	0.3	0.1
1–4	2891	85.0	5.5	6.2	1.6	1.1	0.3	0.2	0.2
5–9	3545	75.8	8.1	10.3	2.8	2.1	0.7	0.1	0.4
10–14	3400	74.2	7.1	10.8	3.1	3.5	1.2	0.1	0.5
15–19	2662	72.0	6.1	10.7	3.8	5.1	2.0	0.2	0.8
20–24	1986	73.6	4.8	9.7	2.8	6.4	2.3	0.4	0.8
25–29	1812	69.4	5.7	10.0	3.3	8.5	2.5	0.7	0.9
30–34	2096	65.5	6.7	13.1	3.4	8.0	3.1	0.2	1.0
35–44	4672	65.8	6.8	12.5	4.9	6.9	2.5	0.6	1.0
45–54	3695	65.0	6.1	12.4	3.4	9.0	3.4	0.8	1.1
55–64	2843	69.8	4.8	10.2	3.2	8.2	2.8	0.9	1.0
65+	3238	72.8	5.0	11.1	3.1	5.1	2.7	0.3	0.8

TABLE 5.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF APPLES BY SEX AND AGE, JULY 1962 SURVEY

Sex and age	Number of observations	Amount (units)					Mean (units)
		None	1	2	3	4+	
Male							
All ages	32009	93.7	4.0	1.3	0.5	0.6	0.1
Under 1	712	98.7	1.2	0.1	—	—	—
1–4	3062	91.6	6.0	1.5	0.5	0.4	0.1
5–9	3735	91.7	6.1	1.3	0.6	0.3	0.1
10–14	3575	93.9	4.0	1.3	0.3	0.5	0.1
15–19	2597	93.7	2.9	1.4	0.7	1.2	0.2
20–24	1679	94.9	2.8	1.4	0.4	0.4	0.1
25–29	1611	94.1	3.3	1.5	0.8	0.3	0.1
30–34	1974	94.7	3.4	1.0	0.6	0.4	0.1
35–44	4241	95.1	3.1	1.1	0.3	0.5	0.1
45–54	3570	94.2	3.8	0.9	0.4	0.7	0.1
55–64	2597	93.0	3.5	2.0	0.5	1.1	0.1
65+	2656	93.6	3.7	1.4	0.5	0.7	0.1
Female							
All ages	33589	93.5	4.1	1.2	0.5	0.7	0.1
Under 1	743	97.2	2.6	0.1	—	—	—
1–4	2895	90.7	7.1	1.4	0.5	0.3	0.1
5–9	3548	92.4	5.0	1.8	0.4	0.3	0.1
10–14	3492	91.2	5.2	1.3	0.9	1.4	0.2
15–19	2662	94.3	3.1	1.2	0.5	0.9	0.2
20–24	1987	94.8	3.7	0.8	0.1	0.6	0.1
25–29	1813	95.3	3.1	1.1	0.2	0.4	0.1
30–34	2100	95.7	2.9	0.7	0.4	0.4	0.1
35–44	4673	95.0	3.1	1.0	0.3	0.5	0.1
45–54	3698	94.5	3.0	1.3	0.7	0.5	0.1
55–64	2844	92.7	4.1	1.4	0.6	1.2	0.1
65+	3234	92.5	4.2	1.7	0.4	1.2	0.1

TABLE 6.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHOLE MILK BY SEX AND REGION, JULY 1962

Sex and region	Number of observations	Amount (fluid ounces)											Mean (fluid ounces)
		None	1–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40+	
Male														
NE	7,580	21.7	8.3	8.6	12.7	5.7	10.4	4.0	9.4	3.3	9.0	1.5	5.4	14.4
NC	9,006	27.8	6.0	9.0	10.5	7.4	10.0	5.0	7.6	4.0	6.1	1.6	5.0	13.3
S	10,501	42.4	5.0	6.7	12.3	5.1	9.0	3.3	6.2	1.6	5.2	0.7	2.4	9.5
W	4,925	34.8	2.2	6.7	10.5	5.7	11.2	4.8	7.8	1.9	8.1	1.5	4.8	12.9
Female														
NE	8,154	26.0	10.3	11.6	13.1	7.3	9.9	3.6	7.4	2.0	6.1	0.9	1.8	10.8
NC	9,613	34.9	7.0	11.3	12.9	7.1	8.8	4.4	5.2	2.0	3.5	0.8	2.1	9.4
S	10,930	48.0	5.4	8.1	13.7	4.8	7.9	2.3	4.3	1.1	3.0	0.3	0.9	6.9
W	4,871	42.1	3.7	8.3	12.2	6.2	10.1	3.3	6.4	1.0	4.2	0.6	1.8	8.9

TABLE 7.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF WHITE BREAD BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amount (slices)							Mean (slices)
		None	1, 2	3, 4	5, 6	7, 8	9, 10	11+	
Male									
NE	7,585	29.1	22.1	21.0	13.4	6.6	3.9	3.8	3.3
NC	9,010	26.7	23.2	22.2	14.9	6.8	3.4	2.8	3.3
S	10,520	34.4	19.5	20.4	12.9	6.7	3.2	2.8	3.0
W	4,927	36.1	20.8	21.0	12.9	5.3	2.5	1.4	2.7
Female									
NE	8,154	31.4	28.3	25.1	10.2	3.1	1.0	1.1	2.4
NC	9,618	31.4	32.9	23.6	8.4	2.6	0.7	0.4	2.1
S	10,955	36.7	28.7	21.3	9.1	2.6	1.0	0.6	2.1
W	4,870	39.6	29.7	20.0	7.1	2.2	0.7	0.8	1.9

TABLE 8.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF BEEF BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amount (ounces)										Mean (ounces)
		None	1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	17+	
Male												
NE	7,590	64.6	2.7	8.8	5.5	9.0	2.2	3.2	0.8	1.8	1.3	2.7
NC	8,999	64.5	3.1	8.6	7.1	7.9	2.8	2.3	0.5	2.0	1.3	2.6
S	10,509	73.7	2.6	6.9	5.1	5.8	2.0	1.8	0.4	1.1	0.5	1.9
W	4,915	60.0	3.3	9.1	7.4	9.5	2.9	3.4	0.7	2.5	1.3	3.0
Female												
NE	8,166	65.6	3.0	11.7	6.9	7.6	1.6	1.8	0.4	0.9	0.4	2.2
NC	9,603	65.5	4.1	12.1	7.4	6.5	1.5	1.3	0.3	1.0	0.2	2.0
S	10,948	73.5	3.6	10.0	5.4	4.5	1.3	0.8	0.1	0.6	0.2	1.5
W	4,856	60.7	4.2	13.6	8.5	7.7	1.6	1.6	0.4	1.1	0.4	2.4

TABLE 9.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF LETTUCE BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amounts (ounces)							Mean (ounces)
		None	1	2	3	4	5–8	9+	
Male									
NE	7,574	67.7	7.0	11.8	3.5	6.8	2.8	0.4	0.9
NC	9,006	72.4	4.9	9.2	4.1	5.4	3.0	1.0	0.9
S	10,514	80.9	4.8	7.4	1.9	3.5	1.2	0.3	0.5
W	4,928	64.8	7.3	10.4	5.2	9.1	2.8	0.3	1.0
Female									
NE	8,155	65.2	7.9	13.9	3.9	6.2	2.6	0.4	1.0
NC	9,614	72.4	5.5	9.8	3.9	5.3	2.5	0.7	0.8
S	10,950	79.9	4.7	8.5	1.8	3.7	1.1	0.2	0.5
W	4,869	65.9	7.0	10.9	4.2	9.3	2.4	0.4	1.0

TABLE 10.—PERCENTAGE DISTRIBUTION OF "AT HOME" DAILY CONSUMPTION OF APPLES BY SEX AND REGION, JULY 1962 SURVEY

Sex and region	Number of observations	Amounts (units)					Mean (units)
		None	1	2	3	4+	
Male							
NE	7,586	93.6	4.7	1.2	0.2	0.3	0.1
NC	8,997	93.3	3.9	1.4	0.7	0.7	0.1
S	10,500	93.8	3.3	1.6	0.5	0.8	0.1
W	4,926	94.3	4.4	0.8	0.3	0.1	0.1
Female							
NE	8,158	93.9	4.5	1.0	0.2	0.3	0.1
NC	9,620	93.7	3.9	1.1	0.6	0.8	0.1
S	10,939	92.5	3.9	1.7	0.7	1.2	0.2
W	4,872	94.8	4.1	0.9	0.2	0.1	0.1

Tri-City Diet Study*

June–July 1962

Joseph Rivera
Health and Safety Laboratory, U.S. Atomic Energy Commission

Since May 1960 the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium–90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods, representing 19 food categories, are purchased at each of these three cities about every 3 months and are analyzed for strontium–90. Using data from the U.S. Department of Agriculture, "Household Food Survey of 1955," the annual consumption by an average individual can be grouped into the same 19 food categories. The annual dietary intake of strontium–90 can then be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data from the "Household Food Survey of 1955" are based on a weight as purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is de-boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on the trimmed weight. No correction is made for the wasted food.

After two samplings at each city it was found that the calcium content of most food categories did not vary among cities nor did it vary significantly with time. Calcium analyses were, therefore, discontinued and average calcium content of foods was computed and used to estimate the average annual intake of this mineral. The specific numbers used to calculate calcium intake are given in *HASL–113* (*1*).

Results obtained from the ninth sampling of foods (June–July 1962) are presented in table 1. The variation with time of the daily intake of strontium–90 in the three cities is plotted in figure 1.

* *Fallout Program Quarterly Summary Report, HASL–132*, 219–223, Office of Technical Services, Department of Commerce, Washington 25, D.C. (January 1, 1963), price $3.50.

TABLE 1.—AVERAGE PERSON DIETARY CONSUMPTION AND STRONTIUM–90 INTAKE—NINTH SAMPLING

Food category	Average U.S. consumption		New York City June 1962		Chicago July 1962		San Francisco June 1962	
	Food (kg/yr)	Calcium (g/yr)	μμc/kg	μμc/yr	μμc/kg	μμc/yr	μμc/kg	μμc/yr
Bakery products	37	27.0	7.1	263	16.5	611	5.0	185
White grain products	11	10.0	11.0	121	13.0	143	6.8	75
Eggs	16	9.1	0.7	11	—	[a]38	3.0	48
Vegetables, fresh	43	15.0	12.1	520	3.9	168	3.7	159
Vegetables, root	17	6.1	3.4	58	7.5	128	4.1	70
Milk	221	234.5	9.0	1,989	11.5	2,542	2.4	530
Poultry	17	9.2	3.6	61	7.0	119	2.1	36
Fish, fresh	8	10.8	—	[a]3	1.3	10	1.6	12
Flour	43	8.6	2.1	90	8.8	378	5.0	215
Macaroni	3	0.7	5.7	17	6.6	20	3.9	12
Rice	3	1.1	1.0	3	1.5	5	1.2	4
Meat	73	10.9	0.8	58	1.1	80	0.8	58
Fish, shell	1	0.8	4.0	4	1.1	1	3.9	4
Beans, dried	3	2.9	5.2	16	10.9	33	4.6	14
Fruit, fresh	68	13.6	3.7	252	3.4	231	2.3	156
Potatoes	45	5.8	8.6	387	1.6	72	2.9	130
Fruit, canned	26	1.3	1.1	29	1.3	34	0.5	13
Juices, fruit	19	1.7	2.7	51	1.1	21	4.0	76
Vegetables, canned	20	4.2	4.8	96	6.8	136	2.1	42
Annual intake	674	383	6.0	4,029	7.1	4,770	2.7	1,840
Strontium–90 to calcium ratio in total diet			10.5		12.5		4.8	

[a] Estimated from eighth sampling.

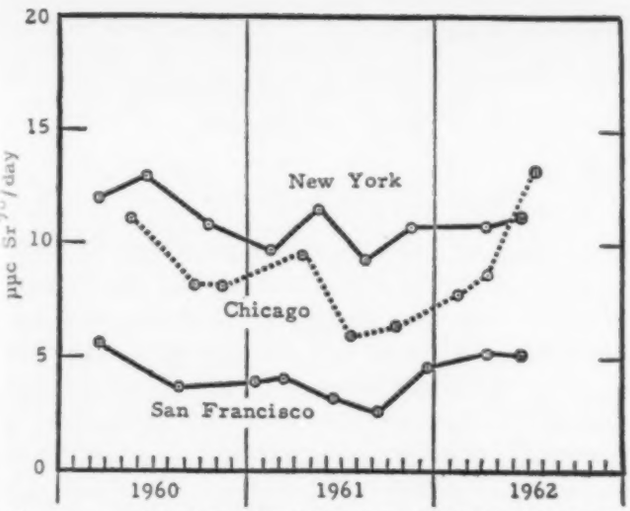

Figure 1.—DAILY INTAKE OF STRONTIUM–90 IN TRI-CITY TOTAL DIETS

Discussion

The greatest difference seen between this sampling and the previous sampling is the sharp increase in the strontium–90 intake at Chicago. This was due principally to the increased strontium–90 levels in milk. Since strontium–89 has a half life of 50 days, the amount of strontium–89 present in a sample relative to a longer-lived nuclide such as strontium–90 is indicative of the age of the fission products. Measurements of strontium–89 in the July Chicago milk sample indicated that much of the strontium–90 in the sample was probably of recent origin.

Chicago during July 1962 had the highest daily intake that has been estimated for any of the cities since the tri-city diet surveys began, and for the first time had a higher strontium–90 intake than that estimated for New York City. It is anticipated, however, that diet levels in New York City will again be found to be higher than those in Chicago in the next sampling, since New York City milk levels have increased significantly since June.

The relative contributions of the 19 dietary components used in the diet surveys to the annual intake of strontium–90 were computed for each city for each of the nine surveys completed so far. Despite the variability found from survey to survey at a given city, the average distribution for the nine surveys at each of the cities was remarkably similar.

These average values and the average value of all three cities combined are shown in table 2. The data in the table suggest that for periods of fallout similar to that experienced in 1960, 1961, and early 1962, good estimates of the Sr^{90}/Ca ratio in the total diet can be made by measuring the strontium–90 and calcium content of only a few foods. If, for example, milk, bakery products, fresh fruits and vegetables, flour, meat, and whole grain products were sampled periodically, they would account for about 75 percent of the strontium–90 and calcium taken in during the year.

TABLE 2.—PERCENTAGE OF TOTAL STRONTIUM–90 INTAKE AND PERCENTAGE OF THE TOTAL CALCIUM INTAKE CONTRIBUTED BY VARIOUS DIETARY COMPONENTS

[Average of 9 samplings, 1960–1962]

Dietary component	Percentage of total Sr^{90} intake				Percentage of total Ca intake
	New York City	Chicago	San Francisco	Tri-city average	Tri-city average[1]
Bakery products	7	10	10	9	9.6
Whole grain products	4	5	5	5	2.6
Eggs	1	1	2	1	2.4
Vegetables, fresh	10	10	7	9	3.9
Vegetables, root	3	3	4	3	1.6
Milk	47	39	37	41	61.1
Poultry	1	1	1	1	2.4
Fish, fresh	0	0	0	0	2.8
Flour	6	10	8	8	2.2
Macaroni	0	0	1	0	0.2
Rice	0	0	0	0	0.3
Meat	1	2	3	2	2.8
Fish, shell	0	0	0	0	0.2
Beans, dried	1	1	1	1	0.7
Fruit, fresh	8	7	7	7	3.5
Potatoes	6	4	6	5	1.5
Fruit, canned	1	1	2	1	0.3
Juices, fruit	1	2	3	2	0.4
Vegetables, canned	2	3	2	2	1.1

[1] See reference 2.

Strontium–90 and Calcium in United States Wheat*

1958–1961

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The contamination of United States wheat crops by strontium–90 has been studied extensively by the Health and Safety Laboratory since 1958. The latest data available in this continuing study are the strontium–90 and calcium concentrations found in wheat harvested in 1961. These data, along with the results obtained from analyses of the 1958, 1959, and 1960 crops, are presented in table 1.

It is apparent from the data presented that there has been no appreciable change in the concentrations of strontium–90 found in the 1961 crop as compared to those found in 1960. The production weighted average (*1*) strontium–90 concentration for the 1961 crop was 23 ± 10 μμc/kg as compared to 24 ± 9 μμc/kg observed in 1960. The average Sr^{90}/Ca ratio was 72 ± 36 strontium units in 1961 as compared to 62 ± 23 strontium units found in 1960.

These investigations are being carried out primarily to add to the understanding of the mechanism of contamination of wheat by strontium–90. As was pointed out previously (*2*), the origin of the strontium in wheat is either the soil or direct deposition on the aerial parts of the plant. An empirical formula has been deduced to express the average contamination of the U.S. wheat crop in terms of the average deposition rate of strontium–90 in June (the principal harvest month) and the estimated cumulative deposit of strontium–90 in the midwest soils. The formula is:

$$V = 0.1\,S + 100\,R,$$

where V is μμc Sr^{90}/g Ca in wheat, S is mc Sr^{90}/mi^2 in soil, and R is mc Sr^{90}/mi^2 deposited in June.

The coefficients of S and R were chosen to fit the data obtained in 1958, 1959, and 1960, but *not* in 1961. The usefulness of the formula depends on how accurately the average Sr^{90}/Ca ratio in wheat can be predicted when S and R are known. Data in table 2 show predicted and observed values of V for 1958 through 1962.

The agreement of the observed with the predicted result for the 1961 wheat crop is gratifying. It will be interesting to see if the predicted value for 1962 agrees with what will be found in this crop, since the observed fallout rate is considerably higher than any previously experienced in June.

* Data from *Fallout Program Quarterly Summary Report, HASL–132*: 224–7, Office of Technical Services, Department of Commerce, Washington 25, D.C. (January 1, 1963), price $3.50.

TABLE 1.—COMPARISON BETWEEN STRONTIUM–90 AND CALCIUM LEVELS IN UNITED STATES WHEAT SAMPLED IN 1958, 1959, 1960, AND 1961

State	g Ca/kg				μμc Sr^{90}/kg				μμc Sr^{90}/g Ca			
	1958	1959	1960	1961	1958	1959	1960	1961	1958	1959	1960	1961
California	[a]—	0.34	0.33	0.30	—	17	3.7	3.4	—	49 [b](2)	11 (5)	11 (2)
Colorado	—	0.49	0.42	0.36	—	46	19	27	—	71 (5)	46 (2)	74 (1)
Idaho	—	0.34	0.35	0.36	—	5.7	6.1	4.6	—	17 (1)	18 (2)	12 (1)
Illinois	0.40	0.38	—	—	133	54	—	—	330 (1)	142 (1)	—	—
Iowa	—	0.54	0.38	0.43	—	62	34	25	—	109 (2)	89 (1)	58 (1)
Kansas	0.36	0.49	0.42	0.28	82	47	26	34	227 (1)	97 (1)	62 (1)	124 (1)
Michigan	0.36	0.38	—	—	42	48	—	—	118 (1)	125 (1)	—	—
Minnesota	0.35	0.33	—	—	51	59	—	—	162 (16)	181 (2)	—	—
Missouri	—	0.43	0.42	0.28	—	121	21	19	—	272 (4)	50 (1)	68 (1)
Montana	0.47	0.38	0.40	0.33	59	20	15	26	125 (1)	52 (1)	38 (1)	80 (1)
Nebraska	—	0.38	0.37	0.32	—	76	32	21	—	159 (3)	68 (3)	64 (4)
New York	0.36	0.37	0.41	0.31	44	44	16	25	121 (1)	119 (1)	40 (1)	81 (1)
North Dakota	0.31	0.33	0.29	0.33	40	51	26	13	134 (10)	154 (1)	91 (1)	40 (1)
Ohio	—	0.36	0.48	0.34	—	56	35	26	—	152 (11)	73 (4)	78 (1)
Oklahoma	0.35	0.40	0.39	0.40	34	63	35	24	82 (1)	159 (1)	90 (2)	60 (1)
South Dakota	0.35	—	—	—	61	—	—	—	171 (8)	—	—	—
Texas	0.44	0.51	—	0.40	44	51	—	14	99 (2)	99 (1)	—	34 (1)
Utah	—	0.48	0.44	0.39	—	21	7.9	3.0	—	45 (5)	19 (4)	8 (1)
Washington	—	0.32	0.35	0.38	—	9.2	7.0	7.4	—	30 (2)	20 (1)	20 (1)

[a] Dash indicates no sample.
[b] Numbers in parentheses are the number of samples.

REFERENCES

(1) Hansen, Harry (Ed.): *The World Almanac 1962 and Book of Facts*, New York World Telegram Corporation, New York (1962), p. 665.

(2) Rivera, J.: Strontium–90 Levels in U.S. Wheat and Milling Products through 1960, *Fallout Program Quarterly Summary Report, HASL–122*, 188–92, Office of Technical Services, Department of Commerce, Washington 25, D.C. (April 1, 1962), Price $3.00.

TABLE 2.—STRONTIUM–90 ACTIVITY IN U. S. SOIL AND WHEAT

Harvest year	Soil activity[1] (S) mc Sr^{90}/mi^2	June deposition rate[2] (R) mc Sr^{90}/mi^2	$\mu\mu c$ Sr^{90}/g Ca in wheat	
			Predicted (V)	Observed
1958	46	1.49	154	172
1959	66	1.45	152	147
1960	70	0.48	55	62
1961	74	0.62	69	72
1962	[3] (88)	[3] (3.22)	331	—

[1] Estimated from cumulative soil strontium–90 measurements and integrated monthly fallout collections.

[2] Estimated from monthly fallout collections in approximately 10 States.

[3] Estimated from preliminary data obtained for June deposition.

For purposes of comparison with findings in the United States concerning strontium–90 in diet, the following summary presents corresponding information from the United Kingdom. Conclusions drawn from direct comparisons between the radionuclide contents of the same food items for each country should be qualified. For example, about a third of the United Kingdom's meat supplies are imported from the Southern Hemisphere where fallout is lower.

Strontium–90 in Diet in the United Kingdom[1]

1958–1961

Agricultural Research Council Radiobiological Laboratory

Responsibility for the investigation of the contamination of human food with radioactive substances in the United Kingdom was assigned in 1957 to the Agricultural Research Council (ARC). In 1958, when surveys of radioactivity in human diet were begun in the ARC Radiobiological Laboratory (ARCRL), attention was confined to strontium–90 as this is the long-lived component of world-wide fallout which delivers the highest radiation doses to man through the contamination of his food. Some measurements of the shorter-lived isotope, strontium–89, were also made, but their primary purpose was to provide information on the mechanisms by which strontium–90 enters the diet. The sampling network devised for strontium–90 later provided a basis for measurements of iodine–131, barium–140, and cesium–137.

[1] Summarized from the following reports:
Agricultural Research Council Radiobiological Laboratory: *Strontium–90 in Human Diet in the United Kingdom, ARCRL–1,* Her Majesty's Stationery Office, London (1958), price 4s.
Agricultural Research Council Radiobiological Laboratory: *Strontium–90 in Human Diet in the United Kingdom, ARCRL–3,* Her Majesty's Stationery Office, London (1959), price 3s. 6d.
Agricultural Research Council Radiobiological Laboratory: *Interim Report on Radioactivity in Diet, ARCRL–5,* Her Majesty's Stationery Office, London (May 1962), price 2s. 0d.
Agricultural Research Council Radiobiological Laboratory: *Annual Report 1961–62, ARCRL–8,* Her Majesty's Stationery Office, London (September 1962), price 6s. 6d.

Basis of Investigations

In any investigation of strontium-90 in the human diet the ultimate objective is to estimate the radiation dose which the skeleton will receive. This depends on the distribution and concentration of strontium–90 in the skeleton, that is to say, on the quantity of strontium–90 laid down per unit weight of new bone. Because strontium and calcium are transferred from the diet to bone in a relatively constant ratio, calcium effectively dilutes the strontium–90 in the skeleton and the resultant dose is determined by *the ratio of strontium–90 to calcium in the total diet* and not by its content of strontium–90 alone. It is, therefore, most important to determine this ratio, which is conventionally expressed in terms of picocuries (pc) of strontium–90 per gram of calcium. However, when the ratio is calculated for foods which contribute only a small fraction of the total calcium in diet, it provides no indication of the effective dose of radiation to the skeleton; if, for example, the ratio of strontium–90 to calcium were 100 in an article of diet which provides only 1 percent of the total calcium in diet, the strontium–90 in that food would lead to a ratio of strontium–90 to calcium of only 1 in the total diet. Accordingly, when individual articles of diet are investigated, the objective must be to determine the quantities of both strontium–90 and calcium which they provide

to the total diet so that the total quantity of each can be calculated, and the appropriate ratio for the whole diet determined.

Standards

The Medical Research Council has recommended that the maximum permissible levels of strontium–90 in bone for the population as a whole and for individual members of it are 67 and 200 pc/g Ca respectively. In deriving the levels of strontium–90 which are acceptable in articles of diet it has been taken into account, *firstly*, that the Medical Research Council recommended that the situation should be reassessed if the level of strontium–90 in the bones of any age group of the general population reached half the maximum permissible level, and, *secondly*, that the ratio of strontium–90 to calcium in the newly formed bone of adults will be about one quarter of that in diet though a high fraction may operate for a time in the very young. On this basis, the following working levels can be derived for assessing the results of surveys of strontium–90 in human diet:

For individuals in the general population: 400 pc Sr^{90}/g Ca.

Average for the population as a whole: 130 pc Sr^{90}/g Ca.

These working levels refer to the average content of the diet over a year. They should not be confused with maximum permissible levels. If continued indefinitely, exposure to the working level would cause approximately half the maximum permissible levels in the bone of the population as a whole.

Sampling Results

When the ARC's sampling program for strontium–90 in the diet began it was necessary to limit the total number of assays to approximately 300 per annum, though some increase in the number later became possible. This number was dictated by the laborious operations which are necessary to separate radioactive strontium from other radioactive materials. To obtain the maximum information in the face of this limitation, it has been necessary to devise elaborate sample collecting schemes so that all samples assayed are truly representative.

TABLE 1.—CALCULATION OF THE MEAN CONTENT OF STRONTIUM-90 IN HUMAN DIET IN THE UNITED KINGDOM, 1958–1961[1]

Food	Calcium[2] Mean daily intake[3] (grams)	1958		1959		1960		1961	
		Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr/^{90}g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)	Mean ratio[3] (pc Sr^{90}/g Ca)	Est. daily intake (pc)
Dairy produce									
Milk and cream	0.496	7.0	3.47	9.8	4.86	6.4	3.17	5.9	2.93
Cheese	0.095	7.7	0.73	7.5	0.71	5.3	0.50	4.8	0.46
Vegetables & Fruit									
Root vegetables	0 025	14.2	0.35	23.2	0.58	19.6	0.49	24.3	0.61
Leaf & other vegetables	0.038	8.7	0.33	14.3	0.54	8.5	0.32	10.3	0.39
Fruit, etc	0.024	8.7	0.21	14.3	0.34	8.5	0.20	10.3	0.25
Flour & cereal all types	0.047	15.9	0.75	28.0	1.32	22.7	1.07	21.8	1.02
Other animal produce									
Eggs	0.019	2	0.04	9.0	0.17	6.3	0.12	6.3	0.12
Meat	0.019	14	0.27	19.6	0.37	12.8	0.24	11.8	0.22
Fish	0.014	<1	<0.01	<1	<0.01	<1	<0.01	<1	<0.01
Other sources	0.004	—	—	—	—	—	—	—	—
Total in food	0.78	7.9	6.16	11.4	8.90	7.8	6.12	7.7	6.01
Creta praeparata (mineral calcium)	0.243	—	—	—	—	—	—	—	—
Total in foodstuffs	1.024	6.0	6.16	8.7	8.90	6.0	6.12	5.9	6.01
Drinking water	0.060	—	0.23	—	0.43	—	0.36	—	0.25
Tea	—	—	—	—	0.45	—	0.45	—	<0.45
Total	1.084	5.9	6.39	9.0	9.78	6.4	6.93	6.2	6.71

[1] Adapted from Table 13, p. 22, ARCRL: *Annual Report 1961–2, ARCRL–8.*
[2] Ministry of Agriculture, Fisheries and Food: *Domestic Food Consumption and Expenditures, 1958*, H.M.S.O., London (1960).
[3] For details of calculations see Agricultural Research Council Radiobiological Laboratory, Reports *ARCRL 1, 3, 5, 8.*

The manner in which milk distribution in the United Kingdom is organized made it possible to apply a detailed statistical sampling scheme to obtain representative samples. On two days in every month samples representative of a day's throughput are collected at over 200 depots, which handle more than 40 percent of the country's total production. The milk is combined, in proportion to the production of the depots, to give duplicate samples from each of ten zones. Analyses are made on bulked produce from either three or six collections. This scheme enables the sampling and analytical error to be estimated.

Table 1 summarizes the results of the ARC human diet sampling program for the period 1958–1961. Mean daily intake of calcium in various foods and the measured annual average ratios of strontium–90 to calcium are shown, together with the daily intake of strontium–90 calculated from these values.

Table 1 is divided horizontally into three parts. The first section contains the data for the five food categories—dairy products, vegetables and fruits, flour and cereal, other animal products, and other sources—together with the total (total in food) from these items. The second section contains the contributions of *creta praeparata** and the total (total in foodstuffs) obtained by combining the contribution due to *creta praeparata* to the total in food mentioned above. The last section includes the data for water and tea along with the total (total) secured by combining the contribution of these beverages to the total in foodstuffs.

Table 2 shows a comparison of the ratios of strontium–90 to calcium in milk and in all foods for the same period.

TABLE 2.—COMPARISON OF RATIOS OF STRONTIUM-90 TO CALCIUM IN MILK AND ALL FOODS, 1958–1961

Year	Ratio: Sr^{90}/Ca (pc/g)		Ratio: Sr^{90}/Ca in milk
	Milk	All Foods[1]	Sr^{90}/Ca in all foods[1]
1958	7.0	6.0	1.16
1958	9.8	8.7	1.12
1960	6.4	6.0	1.07
1961	5.9	5.9	1.00

[1] Excluding drinking water and tea.

* *Creta praeparata* is mineral calcium which is compulsorily added to white flour. This addition is not necessarily done with wholemeal flour.

Discussion

The ratios of strontium–90 to calcium in dairy produce were similar to the mean ratio in the total average diet (table 2). Variations in the quantities of these foods which are consumed would therefore have had little effect on the average ratio of strontium–90 to calcium in the total diet. The erroneous conclusion has sometimes been drawn that because milk contributes a large part of the total strontium–90 in the diet its exclusion from a mixed diet would reduce the level of strontium–90 in bone. Indeed, under some circumstances the reverse may be true, since if certain diets included abnormally large quantities of foods containing higher ratios of strontium–90 to calcium, such as cereals to which no *creta praeparata* has been added, an increased consumption of milk could reduce appreciably the mean ratio of strontium–90 to calcium in the diet.

The ratio of strontium–90 to calcium in vegetables and fruit considerably exceeded that in the average diet of the population; abnormally large consumption of these foods would, however, have had only a small effect on the average content in the diet because of their relatively small contribution to the total intake of calcium. For example, in 1961, if the daily intake of root vegetables in an otherwise average diet had been doubled, the ratio of strontium–90 to calcium would have been increased by less than 7 percent. Doubling the intake of leaf vegetables, fruit, or meat would have had a smaller effect. A larger change would occur if white bread were replaced by bread made from unfortified wholemeal flour. It appears that this change in 1961 might have caused the ratio of strontium–90 to calcium in the total diet to be increased from 6.2 to about 10.6 pc/g. Such an increment cannot, however, be regarded as representative of the situation for any large section of the population, since wholemeal flour which contains no *creta praeparata* appears to amount to not more than 0.05 percent of the

total flour supplies of the United Kingdom and many users of this product consume also flour to which *creta praeparata* has been added.

In addition to food and water, inhalation makes a contribution to the total intake of strontium–90. It has been estimated that in 1959 inhalation accounted for less than 4 percent of the total intake. The rate of fallout in 1961 was less than half of that in 1959, while the dietary intake was some 70 percent of that in the earlier year. Thus, the relative contribution of inhalation during 1961 may be assumed to have been still smaller.

Between 1958 and 1960 there was a slow but steady decrease in the relative contribution of dairy product to the total intake of strontium–90 in food and a corresponding increase in the relative contributions of vegetables and cereals. This trend continued in 1961. Dairy produce accounted for 56 percent of the total in food as compared with 60 percent in 1960, the relative contribution of vegetables increased from 17 to 21 percent, and that of cereals (17 percent) remained the same as in the previous year.

This situation is compatible with the fallout conditions during 1961. During that part of the year when cattle were grazing and when most vegetables and cereals were being grown, the rate of fallout was lower in 1961 than in any of the previous three years. When the rate of fallout is high the efficient retention of material by pastures and its uptake by foliar and plant-base absorption can, to a considerable extent, offset the effect of the discrimination which occurs in the passage of strontium and calcium from the diet of cattle to their milk; thus the ratio of strontium–90 to calcium in milk can be much higher, relative to those in vegetables and cereals, than it would be if strontium–90 were entering from the soil. When the rate of fallout is low and most of the strontium–90 in the diet is entering by absorption from the soil, the effect of this discrimination becomes more marked, although for some time it may be partially offset by continued uptake of strontium–90, undiluted with calcium, by plant-base absorption from the surface "mat" which characterizes many pastures.

Summary

In 1958 the estimated mean strontium–90 to calcium ratio in the average diet for the whole population in the United Kingdom was 5.9 pc/g.

It is estimated that the mean ratio of strontium–90 to calcium in the average diet of the whole population in the United Kingdom during 1959 was 9.0 pc/g and that it did not exceed 15 pc/g in the diet of any large section of the population. Because of the relatively high levels of contamination early in the year these values are about 50 percent higher than those estimated for 1958. The estimated level in the diet of the population as a whole, however, represents less than one-tenth of the working level derived from the recommendations of the Medical Research Council.

During 1960, the strontium–90 to calcium in the diet had dropped to 6.4 pc/g.

The ratio of strontium–90 to calcium in the total diet in 1961 was 6.2 pc/g, a value similar to that for 1960. The ratio of strontium–90 to calcium in infant diets for 1961 was 5.9 pc/g, if it is assumed that milk was their sole diet.

SECTION III.—MILK

Milk Surveillance

Though milk is only one of the many sources of dietary intake of radionuclides, it is the single food item most often used as an indicator of the population's intake of radionuclides from the enviroment. This is because milk is a basic constituent of the diet of a substantial proportion of the U.S. population and contains most of the radionuclides identified as being biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples which are representative of milk consumption in any area can be readily obtained.

PASTEURIZED MILK NETWORK
November 1962

Division of Radiological Health and Division of Environmental Engineering and Food Protection, Public Health Service

In 1957 the Public Health Service began analyzing raw milk to determine relationships between dairy practices and radionuclide levels in milk. However, it became evident that the milk actually consumed by the population should be included in a broader sampling program. In 1960 the pasteurized milk network was initiated to provide data representative of the milk consumed in selected municipalties. Both raw and pasteurized milk sampling data were reported concurrently until June 1961 to premit comparison of the differences between the earlier, limited, milkshed sampling results and those exhibited in pasteurized milk monitoring. Since June 1961, raw milk sampling has been carried out for investigative rather than monitoring purposes.

During November 1962, pasteurized milk surveillance was conducted at 62 Pasteurized Milk Network stations with the cooperation of State and local milk sanitation agencies which have been shipping samples to the PHS Southwestern, Southeastern, and Northeastern Radiological Health Laboratories for analysis. Publication in *Radiological Health Data* follows 3 to 4 months after sample collection because of the time required for shipment, processing, radioanalysis of strontium, data compilation, and publication procedures. Data from gamma analyses (iodine–131) are available to State public health officials and the Federal Radiation Council within 3 days after sample collection for possible countermeasure purposes.

Sampling and Compositing Procedures

The current program emphasizes (1) measurement of the concentrations of radioactivity in samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within all States; additional points are sampled

when indicated by widely varying conditions of the milk supply or when needed in order to cover large population groups. Each sample is composited from subsamples collected from each plant in proportion to the relative volumes of milk sold. The objective of this sampling program is to reflect about 90 percent of each city's milk supply. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since the resumption of nuclear weapons testing, the sampling frequency has been increased. During November 1962, most stations were sampled twice a week. All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evluation and adjustment of the sampling frequency and analytical schedule for this program.

Iodine–131, cesium–137, and barium–140 are determined by gamma scintillation spectroscopy,[1] while strontium–89 and strontium–90 are determined by radiochemical procedures. The minium detectable concentrations in units of μμc/liter are: Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

Table 1 presents summaries of all available analyses for November 1962. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average.

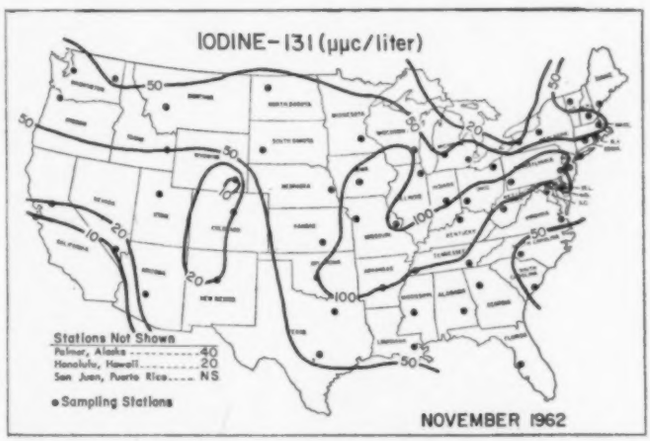

Figure 1.—IODINE–131 CONCENTRATIONS IN PASTEURIZED MILK

[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

Discussion of the Data

The November 1962 monthly average iodine–131 concentrations in milk ranged from 10 to 170 μμc/liter. Most of the country had values between 50 and 100 μμc/liter, while the Southwest reported values below 50 μμc/liter (see figure 1). A ridge of high iodine–131 concentration (> 100 μμc/liter) extended from Pennsylvania to Oklahoma and from Oklahoma to Wisconsin. Measured concentrations in Palmer, Alaska decreased from 270 to 40 μμc/liter from October to November.

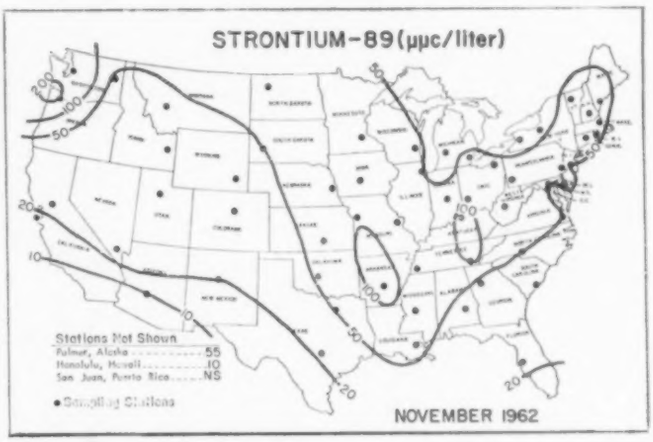

Figure 2.—STRONTIUM–89 CONCENTRATIONS IN PASTEURIZED MILK

The great majority of stations had strontium–89 November monthly average concentrations in milk of 20 to 70 μμc/liter, the western portion of the nation reporting the lower values (see figure 2). Three areas, eastern Kentucky-Tennessee, Missouri-Arkansas, and western Oregon-Washington, had monthly average concentrations greater than 100 μμc/liter. Portland, Oregon, averaged the highest (200 μμc/liter) strontium–89 concentration in milk for November. The Palmer, Alaska monthly average decreased from 150 to 55 μμc/liter from October to November. This station had relatively large strontium–89 and iodine–131 concentrations in milk compared to the continental U.S. during September and October 1962 (reported in previous issues of *RHD*), indicating that large amounts of fission products were being deposited there.

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, NOVEMBER 1962

[Average radioactivity concentrations in μμc/liter]

Sampling locations		Calcium (g/liter)		Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
		Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month
Ala:	Montgomery	1.22	1.28	35	40	13	17	10	70	35	35	10	20
Alaska:	Palmer	1.08	1.32	75	55	12	12	250	40	55	60	30	10
Ariz:	Phoenix	1.08	1.34	10	10	2	4	10	30	15	15	10	10
Ark:	Little Rock	1.21	1.28	80	110	29	28	10	100	55	65	20	30
Calif:	Sacramento	1.11	1.31	5	30	3	4	20	20	20	25	20	10
	San Francisco	1.13	1.37	10	15	4	4	20	10	20	20	20	<10
Colo:	Denver	1.11	1.25	55	25	15	8	30	20	75	50	10	<10
Conn:	Hartford	1.10	1.13	30	50	12	14	30	50	70	70	<10	10
Del:	Wilmington	1.09	1.08	40	70	13	16	30	140	70	70	<10	30
D. C:	Washington	1.16	1.22	45	50	17	18	20	80	60	60	10	20
Fla:	Tampa	1.23	1.26	20	30	11	11	<10	80	145	140	<10	10
Ga:	Atlanta	1.23	1.25	45	45	19	15	20	80	55	50	10	20
Hawaii:	Honolulu	1.07	1.26	10	10	4	5	10	20	35	40	<10	<10
Idaho:	Idaho Falls	1.09	1.29	45	25	11	12	40	50	75	70	20	10
Ill:	Chicago	1.14	1.12	35	50	14	13	50	60	60	65	<10	<10
Ind:	Indianapolis	1.11	1.16	40	55	16	14	30	90	40	55	<10	10
Iowa:	Des Moines	1.10	1.40	80	70	14	11	60	120	40	50	20	20
Kans:	Wichita	1.12	1.35	60	55	13	11	40	80	40	35	10	20
Ky:	Louisville	1.19	1.24	75	120	22	25	20	130	35	50	20	40
La:	New Orleans	1.22	1.29	75	65	30	20	10	60	80	55	20	20
Maine:	Portland	1.15	1.15	45	65	15	16	30	70	120	115	<10	20
Md:	Baltimore	1.16	1.24	40	45	18	17	20	80	60	60	<10	20
Mass:	Boston	1.12	1.10	45	60	21	20	30	40	125	110	10	20
Mich:	Detroit	1.10	1.14	35	60	12	19	50	80	70	70	<10	20
	Grand Rapids	1.15	1.20	35	40	10	15	40	50	60	70	<10	10
Minn:	Minneapolis	1.10	1.27	85	70	21	20	40	80	95	90	20	20
Miss:	Jackson	1.26	1.30	70	80	21	11	10	80	45	50	20	20
Mo:	Kansas City	1.07	1.34	80	90	14	15	50	140	35	50	20	40
	St. Louis	1.08	1.37	60	60	16	12	40	80	40	45	20	10
Mont:	Helena	1.14	1.36	80	40	15	14	50	70	85	80	20	40
Nebr:	Omaha	1.12	1.34	85	65	14	16	60	80	50	50	20	20
Nev:	Las Vegas	1.06	1.30	25	30	5	6	30	10	35	45	<10	10
N. H:	Manchester	1.13	1.20	45	55	17	17	30	40	145	120	<10	10
N. J:	Trenton	1.12	1.11	35	50	12	16	20	90	65	70	<10	20
N. Mex:	Albuquerque	1.10	1.31	20	20	5	4	30	20	25	25	10	20
N. Y:	Buffalo	1.10	1.07	35	35	15	14	40	20	70	85	<10	<10
	New York	1.08	1.10	40	55	16	16	40	80	80	75	<10	20
	Syracuse	1.11	1.15	40	35	12	13	40	40	60	75	10	<10
N. C:	Charlotte	1.23	1.29	55	50	23	14	<10	30	50	50	10	20
N. Dak:	Minot	1.11	1.35	100	60	22	24	80	60	80	70	20	<10
Ohio:	Cincinnati	1.12	1.17	45	80	13	20	40	140	40	50	<10	20
	Cleveland	1.11	1.16	30	55	14	14	40	80	55	60	<10	10
Okla:	Oklahoma City	1.16	1.22	60	65	17	16	20	100	45	40	10	20
Ore:	Portland	1.12	1.39	60	200	12	16	20	80	65	70	10	50
Pa:	Philadelphia	1.14	1.12	30	60	14	15	30	130	70	65	<10	20
	Pittsburgh	1.12	1.14	40	70	18	20	30	170	85	80	<10	30
P. R:	San Juan	1.19	[a]—	25	—	11	—	<10	—	35	—	00	—
R. I:	Providence	1.11	1.07	35	55	13	18	20	80	85	85	<10	20
S. C:	Charleston	1.21	1.28	45	40	20	18	10	40	65	60	<10	10
S. Dak:	Rapid City	1.06	1.12	85	50	20	11	70	90	60	70	20	10
Tenn:	Chattanooga	1.25	1.29	65	100	23	15	10	90	55	55	10	30
	Memphis	1.22	1.27	60	80	21	22	10	100	25	45	20	30
Tex:	Austin	1.16	1.24	15	25	6	8	<10	60	20	20	<10	10
	Dallas	1.18	1.25	40	50	14	13	10	80	30	40	<10	20
Utah:	Salt Lake City	1.10	1.36	60	35	12	12	320	30	95	65	40	20
Vt:	Burlington	1.10	1.12	45	60	14	16	20	70	110	85	<10	20
Va:	Norfolk	1.20	1.24	55	50	22	19	10	60	75	65	<10	20
Wash:	Seattle	1.10	1.37	45	145	15	19	30	90	90	85	20	60
	Spokane	1.15	1.40	40	45	14	14	50	40	70	80	10	20
W. Va:	Charleston	1.16	1.26	80	75	24	21	20	70	45	55	10	30
Wis:	Milwaukee	1.10	1.20	30	55	9	14	50	100	60	70	<10	20
Wyo:	Laramie	1.11	1.32	125	40	15	10	190	10	110	60	50	10
Network average		1.14	1.24	49	57	14.8	14.6	40	70	62	62	12	19

[a] Dash indicates no sample.

San Juan, Puerto Rico and Honolulu, Hawaii have had low concentrations (usually comparable to the Southwest) of strontium–89 and iodine–131 in milk during the period August through November 1962.

The November monthly average strontium–90 concentration map (figure 3) appears similar to the one for the previous month. The Southwest reported values below 10 μμc/liter, while all the northern States reported values near 20 μμc/liter. There also seemed to be a ridge of higher (> 20) strontium–90 concen-

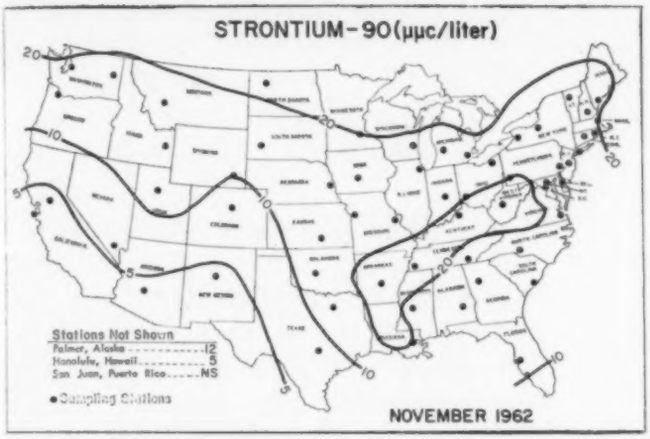

Figure 3.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

trations extending from West Virginia to Arkansas and from Arkansas to Louisiana.

Selected Monthly Strontium–90 Profiles

In previous issues of *RHD*, the average monthly strontium–90 concentrations in pasteurized milk from selected cities in the monitoring program were published. Profiles for an additional 15 cities are presented in figure 4. These graphs show the strontium–90 concentrations in milk from selected cities in the U.S. Department of Agriculture marketing regions of the United States.

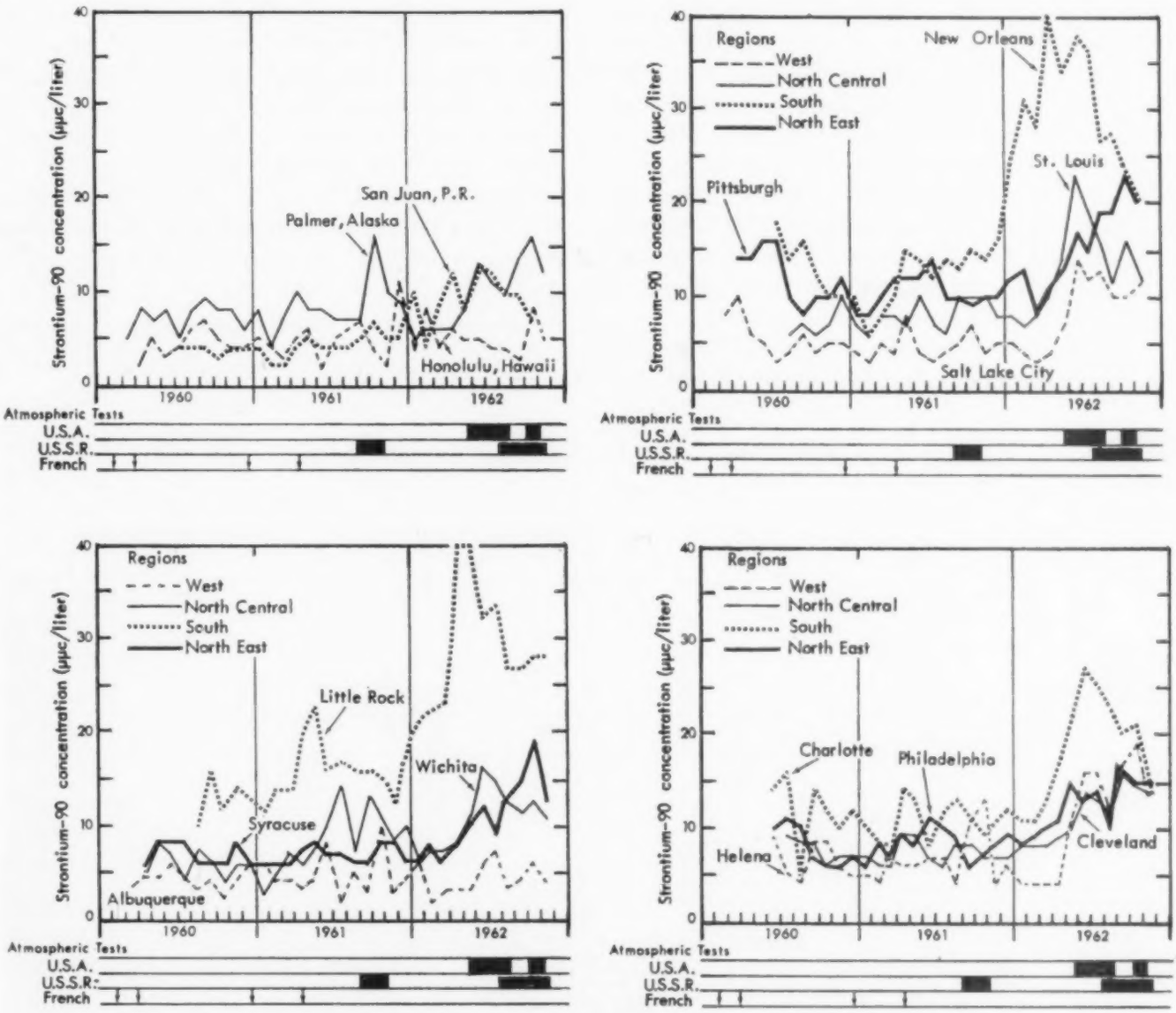

Figure 4.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

INDIANA MILK NETWORK
November–December 1962

Bureau of Environmental Sanitation
Indiana State Board of Health

The Indiana State Board of Health began sampling pasteurized milk for radiological analyses in September 1961. Indiana was geographically divided into five major milksheds, and one large dairy within each milkshed was selected as a sampling station (see figure 5).

The milk samples are routinely analyzed for iodine–131, cesium–137, barium-lanthanum–140, strontium–89, and strontium–90. Analyses for the gamma emitters iodine–131, cesium–137, and barium-lanthanum–140 are conducted on a weekly basis except when iodine–131 results exceed 100 μμc/liter, at which time the frequency of sampling is increased. Strontium–90 analyses are performed monthly on samples which are composited weekly.

The ion exchange analytical procedure (*1*) is used for strontium–89 and strontium–90 analyses. A 512-channel pulse-height analyzer and shielded 4 × 4-inch sodium iodide crystal are used for the gamma analysis of iodine–131, cesium–137, and barium-lanthanum–140.

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 2. The State average is an arithmetic average of the station values.

Figure 5.—INDIANA MILK SAMPLING LOCATIONS

REFERENCE

(*1*) Porter, C., and D. Cahill, R. Schneider, P. Robbins, W. Perry, B. Kahn: Determination of Strontium–90 in Milk by an Ion Exchange Method, *Analytical Chemistry 33*:1306–8, 1961.

TABLE 2.—RADIONUCLIDES IN INDIANA MILK, NOVEMBER–DECEMBER 1962

[Concentrations in μμc/liter]

Sampling location	Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
	November	December	November	December	November	December	November	December	November	December
Evansville	135	[a]	25	[a]	110	20	40	45	10	<10
Fort Wayne	75	[a]	14	[a]	40	10	50	45	<10	<10
Indianapolis	80	[a]	29	[a]	100	30	45	50	<10	<10
Rochester	60	[a]	23	[a]	60	20	50	50	<10	<10
Seymour	70	[a]	23	[a]	80	30	50	50	<10	10
State average	85	[a]	23	[a]	80	20	45	50	<10	<10

[a] Available next month.

NEW YORK MILK NETWORK
September 1961–October 1962

Division of Special Health Services
State of New York Department of Health

Milk samples, collected routinely from five cities—Albany, Buffalo, Newburgh, New York City, and Syracuse (figure 6) are analyzed for radionuclide content by the State of New York Department of Health. The pasteurized milk samples are collected daily and composited weekly for strontium–89, strontium–90, and iodine–131 analyses.

At Albany and New York City daily iodine–131 analyses have been made. In the event that a city reports iodine–131 concentrations exceeding 100 pc/liter, increased surveillance is undertaken. The matrix method (*1*) is used for the analysis of spectral data to determine the concentrations of gamma-emitting nuclides in milk. With this method, the individual nuclide contributions to the gamma spectrum were separated by solution of simultaneous equations describing the spectral interferences.

The analytical procedure for strontium–89 and strontium–90 is based on ion exchange methods to concentrate the strontium, elution of strontium from the ion exchange resin with sodium chloride, gathering by means of sodium carbonate, isolation by means of ethylenediaminetetraacetic acid (EDTA) and counting with a low background beta counter having a 0.8 mg/cm^2 window. The strontium–90 is differentially estimated by a second count 40 hours later to determine the rate growth of its daughter product, yttrium–90.

Figure 6.—NEW YORK MILK SAMPLING LOCATIONS

TABLE 3.—RADIONUCLIDES IN NEW YORK MILK, SEPTEMBER 1961–OCTOBER 1962

[Concentrations in pc/liter]

Sampling location and radionuclide	Sep 61	Oct 61	Nov 61	Dec 61	Jan 62	Feb 62	Mar 62	Apr 62	May 62	Jun 62	Jul 62	Aug 62	Sep 62	Oct 62
Albany														
Strontium–89	75	100	180	25	5	—[a]	5	—	55	90	30	25	25	50
	(1)[b]	(1)	(2)	(2)	(3)		(1)		(17)	(3)	(4)	(5)	(4)	(4)
Strontium–90	6	4	8	7	9	9	6	8	10	10	11	14	9	11
	(3)	(1)	(4)	(3)	(4)	(4)	(4)	(15)	(21)	(4)	(4)	(5)	(4)	(4)
Iodine–131	95	90	65	20	20	20	—	20	25	20	25	20	50	40
	(9)	(22)	(25)	(22)	(23)	(12)		(3)	(26)	(26)	(24)	(28)	(24)	(26)
Buffalo														
Strontium–89		265	460	25	—	—	—	—	115	55	—	—	35	42
		(1)	(1)	(2)					(1)	(2			(1)	(6)
Strontium–90		11	9	4	10	8	4	19	41	10	13	—	7	9
		(1)	(4)	(3)	(1)	(1)	(1)	(3)	(1)	(3)	(1)		(1)	(6)
Iodine–131		110	65	—	—	—	—	—	—	25	35	—	40	45
										)	(1)		(4)	(5)
Newburgh														
Strontium–89		310	85	20	—	—	—	40	45	60	30	25	26	100
		(1)	(3)	(2)				(1)	(4)	(3)	(2)	(2)	(1)	(3)
Strontium–90		10	10	7	—	3	7	6	17	15	14	11	12	7
		(1)	(3)	(3)		(1)	(1)	(4)	(4)	(3)	(2)	(2)	(1)	(3)
Iodine–131		60	20	—	—	—	—	—	—	20	20	20	50	45
		(2)	(1)							(3)	(3)	(2)	(8)	(7)
New York City														
Strontium–89		—	—	—	—	—	—	—	70	50	40	40	25	80
									(2)	(3)	(4)	(5)	(3)	(3)
Strontium–90		—	—	—	—	—	—	—	3	14	18	14	16	19
									(2)	(3)	(4)	(5)	(3)	(3)
Iodine–131		—	—	—	—	—	—	—	25	20	30	20	120	75
									(19)	(13)	(16)	(16)	(13)	(17)
Syracuse														
Strontium–89		—	110	15	11	—	—	—	55	97	20	20	28	45
			(2)	(1)	(1)				(3)	(1)	(2)	(1)	(4)	(3)
Strontium–90		3	18	5	7	5	7	7	3	10	10	6	7	11
		(1)	(3)	(2)	(5)	(1)	(4)	(3)	(2)	(1)	(2)	(1)	(4)	(3)
Iodine–131		85	55	—	—	—	—	—	—	—	24	10	55	65
		(1)	(3)								(2)	(2)	(10)	(6)

[a] A dash indicates no sample.
[b] Numbers in parentheses indicate the number of samples upon which the monthly average is based.

Table 3 shows the monthly radionuclide concentration averages from September 1961 through October 1962. The numbers in parentheses below the data values are the number of determinations used to compute the monthly average.

REFERENCE

(*1*) Kahn, B., et al.: *Rapid Methods for Estimating Fission Product Concentrations in Milk, Public Health Service Pub. No. 999–R–2* (in press).

RADIONUCLIDES IN CANADIAN MILK
October 1962

Radiation Protection Division
Department of National Health and Welfare, Ottawa, Canada

Dried Milk Products

Beginning in November 1955, radiochemical analyses of skim milk and buttermilk powders for strontium–90 concentrations were initiated by the Department of National Health and Welfare. Since April 1962, analyses for strontium–89 and cesium–137 have also been included.

Samples are collected through the cooperation of the Dairy Products Division of the Canadian Department of Agriculture, whose dairy products inspectors pick up four 1-pound samples of dried milk from each station (see figure 7) on a monthly schedule.

Figure 7.—CANADIAN MILK SAMPLING STATIONS

No statistical plan is followed for sample collection. Because of uncertainties introduced by this method of sampling, the significance of differences between station-to-station and month-to-month results is not precisely known. However, it is possible to consider all results for a given period of time as being sufficiently random in selection to show any national trend when average values for such periods and all stations are plotted, as in figures 8 and 9.

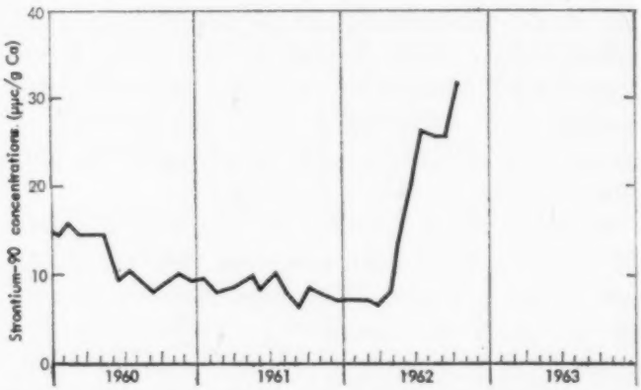

Figure 8.—AVERAGE STRONTIUM–90 CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

A detailed discussion of the sampling and radiochemical procedures employed may be found in the Department's publications (*1*, *2*). Table 4 presents the results of measurements of strontium–89, strontium–90, and cesium–137 in Canadian dried milk powder for October 1962. These data were taken from the "Monthly Report, Radioactive Fallout in Canada," dated December 1962, published by the Radiation Protection Division of the Department of National Health and Welfare.

TABLE 4.—RADIONUCLIDES IN CANADIAN DRIED MILK POWDER, OCTOBER 1962

Station	Strontium-89 (μμc/g Ca)	Strontium-90 (μμc/g Ca)	Cesium-137 (μμc/g K)
Arborg	100.0	26.4	60.0
Calgary	256.0	34.2	117.2
E. Florenceville	167.4	39.1	88.6
Edmonton	222.0	31.0	76.5
Grunthal	119.3	20.8	56.8
Halifax	184.1	35.0	90.2
La Durantaye	284.0	34.3	81.7
Lawrenceville	245.6	42.7	134.1
London	139.9	18.1	56.6
Megantic	314.9	50.6	139.1
Moncton	228.0	47.1	121.4
Nicolet	211.8	28.5	80.0
Ottawa	168.6	17.1	67.9
Saskatoon	127.0	18.0	51.7
Sussex	290.0	47.9	122.1
Vancouver	365.0	34.7	150.6
Walkerton	121.0	18.7	50.0
Average	208.5	32.0	90.9

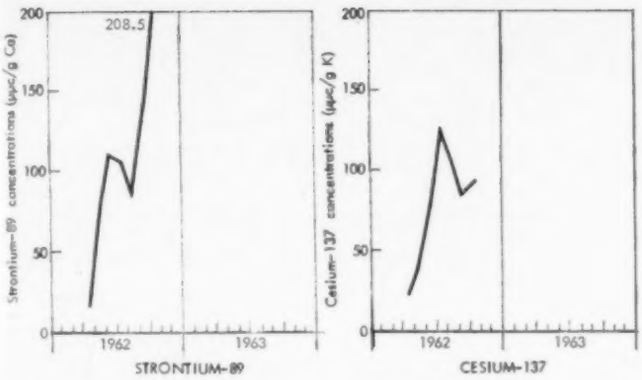

Figure 9.—AVERAGE CONCENTRATIONS IN CANADIAN DRIED MILK POWDER

The network average strontium–90 concentration in milk rose from 26 to 32 μμc/g calcium from September to October.[1] This is an increase of 23 percent. The network average strontium–89 concentrations in milk also increased from 142 to 209 μμc/g calcium from September to October.[1] This is an increase of 47 percent.

For an approximate method to compare the Canadian powdered milk data in units of μμc/g calcium to other milk data in units of μμc/liter, it can be assumed that milk has approximately 1.2 g calcium/liter of liquid milk. Canadian powdered milk data may be compared to liquid milk data by multiplying the former values by 1.2.

The network average cesium–137 concentrations in milk rose from 84 μμc/g potassium in September to 91 μμc/g potassium in October.[1] This is an increase of about 8 percent.

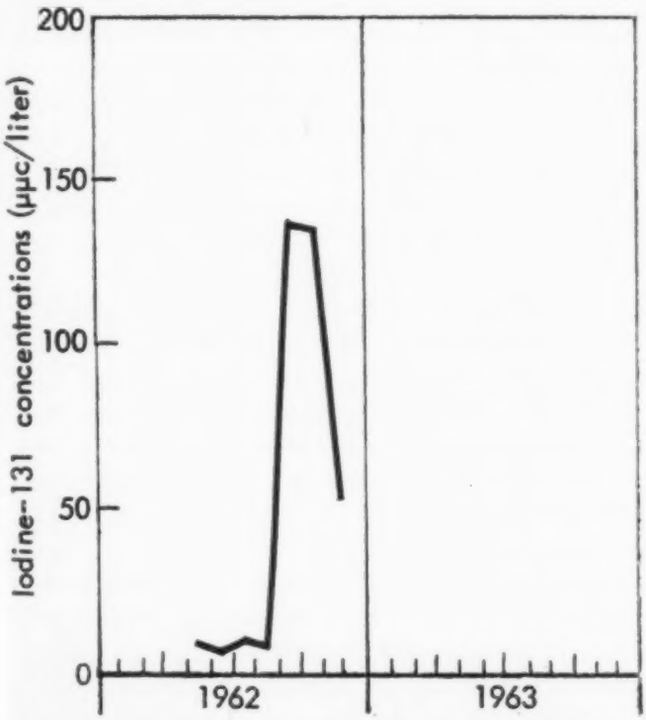

Figure 10.—AVERAGE IODINE–131 CONCENTRATIONS IN CANADIAN WHOLE MILK

[1] Public Health Service: Radionuclides in Canadian Milk, *Radiological Health Data*, *4*:94–6, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (February 1963).

Whole Milk

Recently, monitoring of liquid whole milk for iodine–131 was begun. Table 5 presents the October and November average concentrations of iodine–131 in liquid whole milk for nine cities. It may be noted that the average, which increased to about 135 μμc/liter during September and October, has decreased to 51 μμc/liter for November[1] (see figure 10).

TABLE 5.—IODINE–131 IN CANADIAN LIQUID WHOLE MILK, 1962

[Concentrations in μμc/ liter]

Station	October[a]	November[a]
Calgary	194	114
Halifax	65	38
London	106	51
Ottawa	103	15
Quebec	197	31
Saskatoon	238	84
Sault Ste. Marie	81	24
Vancouver	92	86
Winnipeg	117	14
Average	134	51

[a] Each monthly average is based on about 13 values.

It should be emphasized again that the interpretation of fallout data in relation to health is a complex problem. In comparing the concentrations in a particular medium with the Maximum Permissible Concentrations (MPC) as established by the International Commission on Radiological Protection (*3*), it is necessary to keep in mind that the MPC values refer to conditions of continuous exposure over a lifetime. Therefore, the average levels over an ex-

tended period, such as one year, represent a better basis for comparison than do individual levels at any specific time.

Previous coverage in *Radiological Health Data*:

Period	Issue
Third quarter 1961	*May 1962*
Fourth quarter 1961	*September 1962*
First quarter 1962	*October 1962*
Second quarter 1962	*January 1963*
Third quarter 1962	*February 1963*

REFERENCES

(*1*) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW (RPD–1)*, (July 1958).

(*2*) Mar, Peter G.: *Outline of Procedure for the Radiochemical Analysis of Dried Milk Powders for Strontium and Yttrium, CNHW (RPD–5)*, (June 1, 1960).

(*3*) Recommendations of the International Commission on Radiological Protection: *Report of Committee II on Permissible Dose for Internal Radiation*, Pergamon Press, New York (1959).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

Iodine–131: January 1962–December 1962
Strontium–89 and strontium–90: December 1961–November 1962

Division of Radiological Health, Public Health Service

The guidance of the Federal Radiation Council (FRC) is given in terms of transient rates of intake of radioactive materials in micromicrocuries per day. The action ranges as proposed in FRC Report No. 2 are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations (*1*). The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures. The Council has recently emphasized that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1*, *2*, *3*).

To facilitate comparison of the concentrations of certain radionuclides in milk with the Radiation Protection Guides, tables 1 and 2 below furnish a means towards estimating the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90. The tables are based on the same data which are used for computing the Pasteurized Milk Network monthly averages. They present index values which are the estimated sum of the daily amounts of a radionuclide in one liter of milk for a 12-month period.

The tables show 12-month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12-month index values are for the year beginning one month earlier than the iodine–131 values. The columns of monthly index values in each table are used to compute the net change as the yearly index values are advanced by one month. The following column shows this new 12-month index value. In addition, the first column in table 1 gives the iodine–131 December concentration averages.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks used for any month. Procedures exemplified by (a) and (b) above minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131.

For a number of reasons it is desirable to have a standard quantity of milk to use in the development of index values for the different radionuclides. When one is concerned with strontium, 1 liter is a suitable quantity, as this amount of milk supplies approximately 1 gram of calcium, the amount used by the Federal Radiation Council in deriving the intake guidance for strontium. When one is concerned with iodine–131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18-month group is not more than 1 liter per day. Thus the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

REFERENCES

(*1*) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office (September 1961), price 20 cents.

(*2*) Chadwick, Donald R., and Conrad P. Straub: Considerations in Establishing Radiation Protection Standards for Radioactivity in the Environment, *Radiological Health Data*, *3*:159–65, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (May 1962).

(*3*) Public Health Service: Special Report, *Radiological Health Data*, *3*:ii–iii, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (September 1962).

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE-131 IN ONE LITER OF MILK

[$\mu\mu$c day/liter][a]

Sampling locations		Dec 1962 iodine-131 averages ($\mu\mu$c/liter)	Iodine-131 index values ($\mu\mu$c day/liter)			
			Dec 1961–Nov. 1962	Dec. 1961	Nov. 25, 1962–Dec. 29, 1962	Jan. 1962–Dec. 1962
Ala:	Montgomery	50	4,860	160	1,750	6,450
Alaska:	Palmer	30	36,910	160	1,050	37,800
Ariz:	Phoenix	20	3,870	310	700	4,260
Ark:	Little Rock	170	7,940	620	5,950	13,270
Calif:	Sacramento	20	3,960	310	700	4,350
	San Francisco	30	4,030	160	1,050	4,920
Colo:	Denver	<10	5,700	310	180	5,570
Conn:	Hartford	10	7,480	160	350	7,670
Del:	Wilmington	40	10,490	160	1,400	11,730
D. C:	Washington	30	7,700	310	1,050	8,440
Fla:	Tampa	50	4,690	620	1,750	5,820
Ga:	Atlanta	90	6,260	930	3,150	8,480
Hawaii:	Honolulu	30	3,670	310	1,050	4,410
Idaho:	Idaho Falls	20	8,850	310	700	9,240
Ill:	Chicago	20	13,150	160	700	13,690
Ind:	Indianapolis	50	10,430	310	1,750	11,870
Iowa:	Des Moines	80	19,680	930	2,800	21,550
Kans:	Wichita	80	19,580	930	2,800	21,450
Ky:	Louisville	60	9,060	620	2,100	10,540
La:	New Orleans	110	5,560	930	3,850	8,480
Maine:	Portland	10	7,830	160	350	8,020
Md:	Baltimore	30	7,950	310	1,050	8,690
Mass:	Boston	10	7,910	310	350	7,950
Mich:	Detroit	20	12,140	160	700	12,680
	Grand Rapids	20	8,740	160	700	9,280
Minn:	Minneapolis	20	15,360	310	700	15,750
Miss:	Jackson	100	6,460	1,550	3,500	8,410
Mo:	Kansas City	130	27,060	1,240	4,550	30,370
	St. Louis	30	11,370	310	1,050	12,110
Mont:	Helena	90	11,960	620	3,150	14,490
Nebr:	Omaha	120	16,150	1,240	4,200	19,110
Nev:	Las Vegas[b]	<10	3,780	[c]—	180	3,960
N. H:	Manchester	10	7,100	160	350	7,290
N. J:	Trenton	20	7,450	160	700	7,990
N. Mex:	Albuquerque	40	6,210	160	1,400	7,450
N. Y:	Buffalo	10	8,530	160	350	8,720
	New York	20	11,120	160	700	11,660
	Syracuse	10	9,790	160	350	9,980
N. C:	Charlotte	20	2,830	160	700	3,370
N. Dak:	Minot	10	14,580	160	350	14,770
Ohio:	Cincinnati	60	12,840	620	2,100	14,320
	Cleveland	40	9,860	160	1,400	11,100
Okla:	Oklahoma City	160	13,180	1,240	5,600	17,540
Ore:	Portland	50	8,190	310	1,750	9,630
Pa:	Philadelphia	30	9,790	160	1,050	10,680
	Pittsburgh	50	13,080	160	1,750	14,670
P. R:	San Juan[d]	60	3,390	930	2,100	4,560
R. I:	Providence	20	7,900	160	700	8,440
S. C:	Charleston	70	4,030	310	2,450	6,170
S. Dak:	Rapid City[e]	40	12,710	—	1,400	14,110
Tenn:	Chattanooga	70	6,330	930	2,450	7,850
	Memphis	100	7,370	1,240	3,500	9,630
Tex:	Austin	200	3,960	620	7,000	10,340
	Dallas	330	6,480	310	11,550	17,720
Utah:	Salt Lake City	20	31,240	310	700	31,630
Vt:	Burlington	<10	8,360	160	180	8,380
Va:	Norfolk	40	5,320	310	1,400	6,410
Wash:	Seattle	30	8,910	310	1,050	9,650
	Spokane	20	20,810	160	700	21,350
W. Va:	Charleston	20	6,290	160	700	6,830
Wis:	Milwaukee	20	13,780	160	700	14,320
Wyo:	Laramie	<10	19,970	310	180	19,840

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual iodine-131 intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month I^{131} index × milk consumption factor = 12-month I^{131} intake.
($\mu\mu$c day/liter) (liter/day/person) ($\mu\mu$c/person)

[b] Station included in network in July 1962. Value in last column is for 6 months.

[c] Dash indicates no analysis.

[d] No sample was received in November 1962. Twelve-month sums are therefore for 11 months.

[e] Station began operation in January 1962.

TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

Sampling locations		Strontium-89 index values ($\mu\mu$c day/liter)[a]				Strontium-90 index values ($\mu\mu$c day/liter)[a]			
		Nov. 1961–Oct. 1962	Nov. 1961	Oct. 28, 1962–Nov. 24, 1962	Dec. 1961–Nov. 1962	Nov. 1961–Oct. 1962	Nov. 1961	Oct. 28, 1962–Nov. 24, 1962	Dec. 1961–Nov. 1962
Ala:	Montgomery	18,860	75	1,120	19,905	4,654	180	476	4,950
Alaska:	Palmer	17,845	1,500	1,540	17,885	3,465	300	336	3,501
Ariz:	Phoenix	6,510	300	280	6,490	1,345	390	112	1,067
Ark:	Little Rock	44,020	2,550	3,080	44,550	9,674	390	784	10,068
Calif:	Sacramento	6,125	450	840	6,515	1,324	120	112	1,316
	San Francisco	10,580	150	420	10,850	1,792	60	112	1,844
Colo:	Denver	10,735	750	700	10,685	3,287	150	224	3,361
Conn:	Hartford	7,410	1,200	1,400	7,610	3,681	240	392	3,833
Del:	Wilmington	13,145	2,550	1,960	12,555	4,336	240	448	4,544
D. C:	Washington	12,395	1,500	1,400	12,295	4,613	300	504	4,817
Fla:	Tampa	7,950	900	840	7,890	3,198	180	308	3,326
Ga:	Atlanta	28,035	450	1,260	28,845	6,058	300	420	6,178
Hawaii:	Honolulu	9,460	300	280	9,440	1,909	60	140	1,989
Idaho:	Idaho Falls	8,710	1,050	700	8,360	2,710	120	336	2,926
Ill:	Chicago	11,515	2,700	1,400	10,215	3,604	180	364	3,788
Ind:	Indianapolis	13,525	1,950	1,540	13,115	4,610	270	392	4,732
Iowa:	Des Moines	23,735	2,400	1,960	23,295	4,241	330	308	4,219
Kans:	Wichita	17,660	1,350	1,540	17,850	3,813	240	308	3,881
Ky:	Louisville	24,430	2,100	3,360	25,690	6,241	270	700	6,671
La:	New Orleans	65,550	2,550	1,820	64,820	10,261	420	560	10,401
Maine:	Portland	10,335	1,800	1,820	10,355	4,675	360	448	4,763
Md:	Baltimore	11,635	1,200	1,260	11,695	4,791	210	476	5,057
Mass:	Boston	11,865	2,700	1,680	10,845	5,217	300	560	5,477
Mich:	Detroit	9,995	1,950	1,680	9,725	3,435	210	532	3,757
	Grand Rapids	9,870	2,700	1,120	8,290	3,252	180	420	3,492
Minn:	Minneapolis	22,120	4,200	1,960	19,880	5,063	300	560	5,323
Miss:	Jackson	55,790	2,100	2,240	55,930	8,539	420	308	8,427
Mo:	Kansas City	28,555	2,250	2,520	28,825	4,762	330	420	4,852
	St. Louis	17,965	1,500	1,680	18,145	4,565	300	336	4,601
Mont:	Helena	14,585	750	1,120	14,955	3,557	120	392	3,829
Nebr:	Omaha	22,340	3,000	1,820	21,160	4,055	270	448	4,233
Nev:	Las Vegas[b]	3,045	[c]—	840	3,885	651	—	168	819
N. H:	Manchester	10,385	1,950	1,540	9,975	4,773	330	476	4,919
N. J:	Trenton	9,465	1,350	1,400	9,515	3,802	300	448	3,950
N. Mex:	Albuquerque	5,015	150	560	5,425	1,503	90	112	1,525
N. Y:	Buffalo	9,220	1,800	980	8,400	3,791	180	392	4,003
	New York	10,270	1,800	1,540	10,010	4,637	240	448	4,845
	Syracuse	9,680	1,650	980	9,010	3,650	240	364	3,774
N. C:	Charlotte	18,915	600	1,400	19,715	6,431	330	392	6,493
N. Dak:	Minot	17,650	1,840	1,680	17,490	5,483	270	672	5,885
Ohio:	Cincinnati	17,315	2,400	2,240	17,155	4,777	270	560	5,067
	Cleveland	10,205	1,650	1,540	10,095	3,849	210	392	4,031
Okla:	Oklahoma City	25,040	2,400	1,820	24,460	5,403	240	448	5,611
Ore:	Portland	24,950	5,400	5,600	25,150	4,915	990	448	4,373
Pa:	Philadelphia	9,285	1,500	1,680	9,465	4,207	240	420	4,387
	Pittsburgh	10,510	1,500	1,960	10,970	5,106	300	560	5,366
P. R:	San Juan[d]	24,150	750	—	23,400	3,179	150	—	3,029
R. I:	Providence	10,080	2,700	1,540	8,920	4,151	240	504	4,415
S. C:	Charleston	21,715	450	1,120	22,385	6,225	330	504	6,399
S. Dak:	Rapid City[e]	17,160	—	1,400	18,560	4,474	—	308	4,782
Tenn:	Chattanooga	38,740	1,350	2,800	40,190	7,357	270	420	7,507
	Memphis	36,680	1,950	2,240	36,970	7,063	420	616	7,259
Tex:	Austin	9,525	600	700	9,625	2,290	120	224	2,394
	Dallas	23,000	1,650	1,400	22,750	4,824	300	364	4,888
Utah:	Salt Lake City	10,145	600	980	10,525	2,755	120	336	2,971
Vt:	Burlington	10,545	1,800	1,680	10,425	3,846	330	448	3,964
Va:	Norfolk	17,045	1,500	1,400	16,945	5,784	330	532	5,986
Wash:	Seattle	18,850	2,400	4,060	20,510	5,139	480	532	5,191
	Spokane	11,365	240	1,260	12,385	3,863	180	392	4,075
W. Va:	Charleston	20,180	2,100	2,100	20,180	5,979	300	588	6,267
Wis:	Milwaukee	8,110	1,950	1,540	7,700	2,770	210	392	2,952
Wyo:	Laramie	16,450	75	1,120	17,495	3,127	120	280	3,287

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. Annual strontium-89 and strontium-90 intake per person from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month Sr^{89} or Sr^{90} index ($\mu\mu$c day/liter) × milk consumption factor (liter/day/person) = 12-month Sr^{89} or Sr^{90} intake ($\mu\mu$c/person).

[b] Station included in network in July 1962. Twelve-month sums are therefore for 4 and 5 months, respectively.

[c] Dash indicates no analysis.

[d] No sample was received for November 1962. December 1961–November 1962 twelve-month sum is therefore for 11 months.

[e] Station began operation in January 1962. Twelve-month sums are therefore for 10 and 11 months, respectively.

SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
September 1962

Division of Water Supply and Pollution Control, Public Health Service

The National Water Quality Network was initiated in October 1957 (*1*). This network, operated by the Public Health Service in cooperation with State and local agencies, consisted of 123 sampling stations as of the end of September (figure 1). These stations are located on the major waterways used for public water supplies, propagation of fish and wildlife, and recreational, agricultural, and industrial purposes. Samples are taken weekly, monthly, or continuously, depending on the type of analysis and the water quality. These samples are analyzed for plankton population, organic chemicals, chemical, biological, and physical quality, and radioactivity (*2*, *3*).

The radioactivity associated with dissolved solids provides a rough measure of the levels which may be found in treated water, since nearly all of the suspended matter is removed by treatment processes (*4*). It has been observed that in water the natural environmental beta activity is usually several times that of the natural environmental alpha activity. Nuclear installations may contribute additional alpha or beta activity whereas fallout contributes primarily additional beta activity. Gross alpha and beta measurements are made on both suspended and dissolved solids (strontium–90 on the total solids only) in raw surface water samples according to established procedures (*5*, *6*). Because strontium–90 analyses are done quarterly, the results will be published on this basis.

Figure 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, SEPTEMBER 1962

For the first two years, beta determinations were made on weekly samples, and alpha determinations were generally made on composites of more than one weekly sample. From January

1960 to September 1961, alpha and beta determinations were generally made once a month on weekly composited samples. Beginning in September 1961, alpha determinations have been made on one sample each month, and beta determinations have generally been made on weekly samples. For the first operating year of each new station, sampling, and alpha and beta analysis are done weekly.

If at any time activity significantly greater than the normal environmental levels has been noted, the rate of sampling and analysis has been increased to at least one every week. Since January 1959, a portion of each sample from all stations in the network has been composited into a three-month station sample for measurement of strontium–90 (*7*).

Table 1 presents the results of the alpha and beta analyses on raw surface water in the United States for September 1962. Table 2 shows the strontium–90 quarterly station averages for April 1961 through March 1962.

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(*2*) Division of Water Supply and Pollution Control, Public Health Service: *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, 1960 Edition, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

(*3*) Setter, L. R., and S. L. Baker: Radioactivity of Surface Waters in the United States, *Radiological Health Data, 1*:20–31, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (October 1960).

(*4*) Straub, C. P.: Significance of Radioactivity Data, *Journal of the American Water Works Association, 53*:704 (June 1961).

(*5*) Setter, L. R., J. E. Regnier, and E. A. Diephaus: Radioactivity of Surface Waters in the United States, *Journal of the American Water Works Association, 51*:1377 (November 1959).

(*6*) Robert A. Taft Sanitary Engineering Center, Public Health Service: *Radionuclide Analysis of Environmental Samples, Technical Report, R59–6* (1959).

(*7*) Straub, C. P., L. R. Setter, A. Goldin and P. F. Hallbach: Strontium–90 in Surface Waters in the U.S., *Journal of the American Water Works Association, 52*:756 (June 1960).

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, SEPTEMBER 1962

[Average concentsations in pc/liter]

Station	September 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	3	26	29	0	0	0
Animas River: Cedar Hill, N. Mex	4	30	34	<1	8	8
Apalachicola River: Chattahoochie, Fla	3	4	7	1	0	1
Arkansas River:						
Coolidge, Kans	43	63	106	0	40	40
Ponca City, Okla	148	27	175	13	1	14
Pendleton Ferry, Ark	—	—	—	—	—	—
Bear River: Preston, Idaho	11	38	49	<1	1	1
Bighorn River: Hardin, Mont	82	42	124	6	6	12
Big Sioux River: Sioux Falls, S. Dak	32	65	97	1	1	2
Chattahoochie River:						
Atlanta, Ga	5	7	12	0	0	0
Columbus, Ga	9	9	18	0	0	0
Lanett, Ala	9	10	19	<1	0	<1
Chena Slough: Fairbanks, Alaska	13	25	38	<1	0	<1
Clear Water River: East Lewiston, Idaho	5	10	15	0	0	0
Clinch River:						
Kingston, Tenn	130	7	137	1	0	1
Clinton, Tenn	5	5	10	0	0	0
Colorado River:						
Loma, Colo	47	57	104	7	10	17
Page, Ariz	325	43	368	19	11	30
Boulder City, Nev	7	28	35	0	8	8
Parker Dam, Calif.–Ariz	18	33	51	0	6	6
Yuma, Ariz	120	63	183	1	0	1
Columbia River:						
Northport, Wash	3	13	16	0	<1	<1
Wenatchee, Wash	4	8	12	0	0	0
Pasco, Wash	53	247	300	0	0	0
McNary Dam, Ore	21	238	259	0	0	0
Bonneville, Ore	9	127	136	—	—	—
Clatskanie, Ore	7	101	108	0	0	0
Connecticut River:						
Wilder, Vt	15	13	28	0	1	1
Northfield, Mass	4	14	18	0	0	0
Enfield Dam, Conn	8	12	20	<1	0	<1
Delaware River:						
Martins Creek, Pa	5	10	15	1	0	1
Trenton, N. J	2	12	14	0	<1	<1
Philadelphia, Pa	5	14	19	0	0	0
Escambia River: Century, Fla	19	3	22	0	0	0
Great Lakes:						
Duluth, Minn	3	4	7	—	—	—
Sault Ste. Marie, Mich	4	10	14	0	0	0
Milwaukee, Wis	1	8	9	0	<1	<1
Gary, Ind	3	12	15	0	0	0
Port Huron, Mich	6	6	12	0	0	0
Detroit, Mich	2	3	6	0	0	0
Buffalo, N. Y	18	10	28	0	0	0
Green River: Dutch John, Utah	15	18	33	2	3	5
Hudson River: Poughkeepsie, N. Y	4	28	32	1	0	1
Illinois River:						
Peoria, Ill	11	22	33	1	0	1
Grafton, Ill	14	22	36	1	1	2
Kanawha River: Winfield Dam, W. Va	13	15	28	—	—	—
Klamath River: Keno, Ore	3	10	13	0	0	0
Little Miami River: Cincinnati, Ohio	15	30	45	0	0	0
Mississippi River:						
St. Paul, Minn	8	32	40	0	2	2
Dubuque, Iowa	10	21	31	0	1	1
Burlington, Iowa	19	28	47	0	2	2
E. St. Louis, Ill	15	23	38	0	2	2
Cape Girardeau, Mo	36	25	61	1	2	3
W. Memphis, Ark	22	24	46	3	1	4
Delta, La	14	23	37	0	1	1
New Orleans, La	4	16	20	1	2	3
Vicksburg, Miss	20	26	46	1	1	2

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, SEPTEMBER 1962—Continued

[Average concentrations in pc/liter]

Station	September 1962					
	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Missouri River:						
Williston, N. Dak	33	18	51	0	4	4
Bismarck, N. Dak	10	34	44	1	4	5
Yankton, S. Dak	9	36	45	—	—	—
Omaha, Nebr	81	34	115	3	3	6
St. Joseph, Mo	144	48	192	5	3	8
Kansas City, Kans	91	35	126	3	3	6
St. Louis, Mo	50	36	86	1	2	3
Missouri City, Mo	158	30	188	22	3	25
Monongahela River: Pittsburgh, Pa	4	32	36	0	0	0
North Platte River: Henry, Nebr	11	51	62	1	20	21
Ohio River:						
E. Liverpool, Ohio	—	—	—	—	—	—
Addison, Ohio	8	22	30	<1	0	<1
Huntington, W. Va	6	20	26	0	0	0
Cincinnati, Ohio	10	16	26	0	0	0
Louisville, Ky	4	18	22	0	0	0
Evansville, Ind	5	36	41	0	3	3
Cairo, Ill	5	16	21	0	0	0
Ouachita River: Bastrop, La	7	19	26	0	<1	<1
Pend Oreille River: Albeni Falls Dam, Idaho	2	7	9	0	0	0
Platte River: Plattsmouth, Nebr	134	42	176	6	1	7
Potomac River:						
Williamsport, Md	6	18	24	—	—	—
Great Falls, Md	6	16	22	0	1	1
Rainy River:						
Baudette, Minn	14	43	57	0	0	0
International Fls. Minn	13	18	31	0	0	0
Red River, South:						
Denison, Tex	225	104	329	—	—	—
Index, Ark	82	25	107	22	1	23
Bossier City, La	19	270	289	3	2	5
Alexandria, La	92	19	111	0	1	1
Rio Grande River:						
Alamosa, Colo	14	16	30	<1	2	2
El Paso, Tex	35	35	70	0	5	5
Laredo, Tex	204	26	230	103	4	107
Brownsville, Tex	4	17	21	—	—	—
Roanoke River: John H. Kerr Resr. & Dam, Va	3	10	13	0	0	0
Sabine River: Ruliff, Tex	22	12	34	0	1	1
Sacramento River: Greens Landing, Courtland, Calif	3	4	7	0	0	0
San Joaquin River: Vernalis, Calif	12	14	26	1	8	9
San Juan River: Shiprock, N. Mex	25	33	58	1	7	8
St. Lawrence River: Massena, N. Y	4	10	14	1	1	2
Schuylkill River: Philadelphia, Penn	0	17	17	—	—	—
Savannah River:						
North Augusta, S. C	5	11	16	0	0	0
Port Wentworth, Ga	5	19	24	1	0	1
Shenandoah River: Berryville, Va	17	16	33	<1	0	<1
Snake River:						
Ice Harbor Dam, Wash	2	15	17	<1	2	2
Wawawai, Wash	3	15	18	0	1	1
Payette, Idaho	6	18	24	0	3	3
South Platte River: Julesburg, Colo	8	68	76	0	24	24
Spokane River: Post Falls, Idaho	5	8	13	<1	0	<1
Susquehanna River:						
Sayre, Pa	4	10	14	0	0	0
Conowingo, Md	4	18	22	0	<1	<1
Tennessee River:						
Chattanooga, Tenn	5	20	25	0	1	1
Bridgeport, Ala	3	13	16	0	0	0
Pickwick Landing, Tenn	16	38	54	1	0	1
Lenoir City, Tenn	12	10	22	0	0	0
Tombigbee River: Columbus, Miss	9	7	16	<1	0	<1
Truckee River: Farad, Calif	26	20	46	<1	0	<1
Verdigris River: Nowata, Okla	104	36	140	7	<1	7
Wabash River: New Harmony, Ind	22	27	49	2	<1	2
Willamette River: Portland, Ore	4	4	8	<1	0	<1
Yakima River: Richland, Wash	1	12	13	0	1	1
Yellowstone River: Sidney, Mont	48	31	79	—	—	—

TABLE 2.—QUARTERLY STATION AVERAGE CONCENTRATIONS OF STRONTIUM-90 IN RAW SURFACE WATERS, APRIL 1961–MARCH 1962

[μμc/liter]

Station	Second quarter 1961	Third quarter 1961	Fourth quarter 1961	First quarter 1962
Allegheny River: Pittsburgh, Pa	0.2	0.3	0.6	1.7
Animas River: Cedar Hill, N. Mex.	[a]—	0.3	0.9	0.8
Apalachicola River:				
Chattahoochie, Fla	—	0.4	0.5	[b] 0.9
Arkansas River:				
Coolidge, Kansas	—	2.3	1.0	0.6
Ponca City, Okla	0.7	—	0.6	1.3
Pendleton Ferry, Ark	—	—	0.5	1.3
Bighorn River: Hardin, Mont	—	—	—	[b] 1.5
Big Sioux River:				
Sioux Falls, S. Dak	—	0.4	1.2	2.0
Chattahoochie River:				
Atlanta, Ga	0.3	—	0.3	0.5
Columbus, Ga	—	—	0.1	0.6
Clear Water River:				
Lewiston, Idaho	—	—	0.3	0.5
Colorado River:				
Loma, Colo	—	—	0.8	1.2
Page, Ariz	2.3	—	1.9	1.5
Boulder City, Nev	—	1.0	1.8	1.3
Parker Dam, Calif.-Ariz	—	—	1.5	1.0
Yuma, Ariz	—	—	0.7	0.6
Columbia River:				
Wenatchee, Wash	—	—	0.7	0.9
Pasco, Wash	—	1.1	0.7	1.1
McNary Dam, Ore	—	1.2	0.6	0.9
Bonneville Dam, Ore	—	0.6	0.8	1.1
Clatskanie, Ore	1.1	—	0.6	0.7
Connecticut River:				
Wilder, Vt	—	—	3.7	0.8
Northfield, Mass	—	0.4	0.4	0.6
Cumberland River:				
Clarksville, Tenn				
Delaware River:				
Martins Creek, Pa	0.4	—	0.5	0.7
Trenton, N.J	—	—	0.7	1.0
Philadelphia, Pa	—	—	—	[b] 0.7
Escambia River: Century, Fla	—	0.9	0.5	0.4
Great Lakes:				
Duluth, Minn	—	—	0.1	0.8
Sault Ste. Marie, Mich	—	—	0.5	0.5
Milwaukee, Wis	0.3	—	0.8	0.5
Gary, Ind	—	0.2	0.1	0.9
Port Huron, Mich	—	0.4	0.8	0.8
Detroit, Mich	—	0.6	0.4	1.1
Buffalo, N.Y	—	—	0.8	1.0
Hudson River: Poughkeepsie, N.Y.	0.5	0.2	2.5	1.1
Illinois River:				
Peoria, Ill	—	0.4	0.7	1.0
Grafton, Ill	—	—	0.6	2.5
Kanawha River:				
Winfield Dam, W. Va	—	—	0.5	0.4
Klamath River: Keno, Ore	0.3	—	1.2	1.1
Little Miami River:				
Cincinnati, Ohio	—	1.1	0.6	1.3
Merrimack River: Lowell, Mass	—	0.7	—	—
Mississippi River:				
St. Paul, Minn	—	0.9	0.6	1.3
Dubuque, Iowa	—	—	0.8	0.7
Burlington, Iowa	—	0.6	1.9	1.0
E. St. Louis, Ill	0.5	—	0.9	1.2
Cape Girardeau, Mo	—	0.8	1.0	1.4
W. Memphis, Ark	—	—	1.1	1.5
Delta, La	—	[b] 0.4	1.8	1.0
New Orleans, La	0.6	—	0.7	1.4
Vicksburg, Miss	—	—	0.7	2.0
Missouri River:				
Williston, N. Dak	—	—	1.2	1.4
Bismarck, N. Dak	0.6	—	1.1	1.4
Yankton, S. Dak	—	0.6	2.5	0.7
Omaha, Nebr	0.7	—	0.7	1.0
St. Joseph, Mo	—	—	0.5	1.1
Kansas City, Kans	—	—	0.9	0.5
St. Louis, Mo	—	1.4	2.1	1.3
Missouri City, Mo	—	—	—	1.5
Monongahela River:				
Pittsburgh, Pa	—	0.4	1.3	0.7
North Platte River: Henry, Nebr	—	—	1.3	0.5
Ohio River:				
E. Liverpool, Ohio	—	0.4	—	1.2
Huntington, W. Va	—		1.0	0.6
Cincinnati, Ohio	—	—	0.6	1.2
Louisville, Ky	—	0.4	0.7	1.3
Cairo, Ill	—	1.1	—	1.4
Ouachita River: Bastrop, La	—	—	0.7	2.0
Platte River: Plattsmouth, Nebr	—	—	—	2.2
Potomac River				
Williamsport, Md	0.8	—	0.9	0.5
Great Falls, Md	—	—	0.6	1.1
Rainy River:				
International Fls, Minn	—	—	0.3	1.4
Baudette, Minn	—	—	—	1.4
Red River North:				
Grand Forks, N. Dak	1.5	—	—	—
Red River South:				
Denison, Tex	—	—	2.2	2.2
Index, Ark	—	—	1.7	2.1
Alexandria, La	—	1.0	2.7	1.1
Rio Grande River:				
Alamosa, Colo	—	0.4	—	[b] 0.6
El Paso, Tex	—	—	—	[b] 0.5
Laredo, Tex	—	—	0.6	0.4
Brownsville, Tex	0.3	—	0.6	0.9
Roanoke River:				
John H. Kerr Resr. & Dam, Va	—	—	0.6	0.6
Sabine River: Ruliff, Tex	0.8	—	0.7	1.3
San Juan River: Shiprock, N. Mex	—	—	1.3	1.9
St. Lawrence River: Massena, N.Y	—	—	1.6	0.8
Schuylkill River: Philadelphia, Pa	—	—	—	[b] 0.6
Savannah River:				
North Augusta, S.C	0.5	—	—	0.8
Port Wentworth, Ga	0.5	0.4	0.7	0.9
Shenandoah River: Berryville, Va	—	—	0.2	0.4
Snake River:				
Wawawai, Wash	—	0.3	0.2	0.9
Payette, Idaho	—	—	2.5	0.3
South Platte River:				
Julesburg, Colo	—	0.7	1.2	0.8
Susquehanna River:				
Sayre, Pa	—	0.3	0.2	0.9
Conowingo, Md	—	0.3	0.9	0.5
Tennessee River:				
Chattanooga, Tenn	—	0.6	0.5	0.6
Bridgeport, Ala	0.9	0.7	1.5	2.0
Pickwick Landing, Tenn	—	—	0.4	1.3
Lenoir City, Tenn	—	—	—	1.2
Tombigbee River: Columbus, Miss	—	—	0.2	0.9
Truckee River: Farad, Calif	—	—	0.1	0.8
Wabash River: New Harmony, Ind	—	—	—	1.3
Yakima River: Richland, Wash	—	0.4	0.6	0.6
Yellowstone River: Sidney, Mont	0.8	—	1.2	1.3

[a] Dash denotes no sample received or no determinations made.
[b] Six months composite—added period required to obtain sufficient sample for analysis.

SECTION V.—OTHER DATA

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 22 AEC installations have appeared periodically in *Radiological Health Data* since November 1960. Summaries follow for Feed Materials Production Center and Mound Laboratory.

The measured concentration of a radionuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee on Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in the National Bureau of Standards "Handbook 69" (*1*). The MPC values applicable to the reports that follow are given in table 1.

In these reports, nonspecific terms such as "total activity," "total alpha," and "gross beta" do not in themselves suggest any one MPC value. Often, when concentrations are low a

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line no.	Radionuclide or mixture of unknown nuclides	Environmental MPC's	
		Water ($\mu\mu$c/liter)	Air ($\mu\mu$c/m^3)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226}, Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present[a]	3,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present[a]	600	—
3	If Ra^{226}, Ra^{228} are not present[a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present[a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, Pu^{241} are not present[a]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, Bk^{249} are not present[a]	—	100
8	Plutonium–239	5,000	0.06
9	Polonium–210	700	20
10	Hydrogen–3 (tritium)	3,000,000	200,000
11	Uranium-natural	20,000	2

[a] "Not present" implies that the concentration of the nuclide is small compared with its appropriate MPC. According to AEC regulation (Federal Register, Title 10, Part 20, August 9, 1961), a group of nuclides may be considered not present if the ratio of each nuclide to its appropriate MPC is equal to or less than 1/10 and if the sum of these ratios for the group in question is equal to or less than 1/4.

laboratory will assign an MPC value that is more restrictive than necessary. This avoids the more costly isotopic tests necessary to justify a less restrictive value. References to table 1 will be made to designate the appropriate MPC's adopted by the respective laboratories. As these terms arise in the following reports, the reader is referred to lines in table 1 which show the appropriate MPC's adopted by the respective laboratories.

REFERENCE

(*1*) National Committee on Radiation Protection: *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, National Bureau of Standards Handbook 69*, Superintendent of Documents, Government Printing Office, Washington 25, D.C. (June 5, 1962), price 35 cents.

FEED MATERIALS PRODUCTION CENTER

National Lead Company
Fernald, Ohio

Second Half 1961–First Half 1962

The Feed Materials Production Center (FMPC), located in southwestern Ohio, is operated by the National Lead Company of Ohio (NLO) for the AEC. The location, as related to populated areas, is shown in figure 1.

Operations at this project deal with the processing of high-grade uranium ores and ore concentrates to produce metallic uranium and with the fabrication of the metal into fuel elements.

To check the effectiveness of dust collectors and waste treatment processes, an environmental survey program of air and water sampling is maintained.

This report presents a summary of the data for this program for the second half of 1961 and first half of 1962.

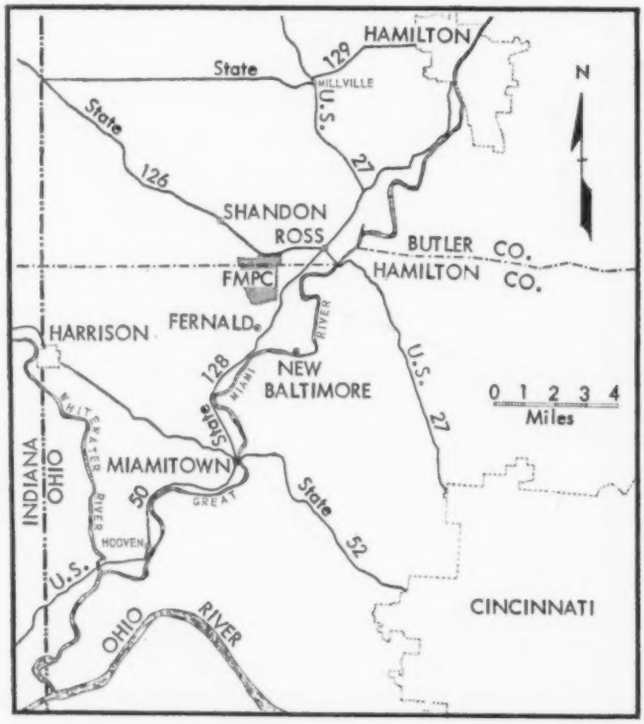

Figure 1.—AREA MAP OF FEED MATERIALS PRODUCTION CENTER

Air Monitoring

FMPC uses dust collectors such as bag collectors, electrostatic precipitators and scrubbing towers which remove nearly all of the airborne particulates generated during the many plant operations. The environmental air sampling program provides an indication of the amount of material released into the atmosphere.

On-site samples were taken by four permanent sampling stations located at the four corners of the production area shown in figure 2. Off-site samples were taken by a mobile unit operated at various distances and directions from the plant. The data for the off-site samples are averaged in groups according to distance from the production area. Concentrations of uranium and total activity of airborne particulates sampled at on-site and off-site locations are given in table 2.

Water Monitoring

Continuous daily samples, collected from the combined sewer leading from the FMPC site to the Great Miami River are analyzed for uranium and total activity. The combined sewage is composed of treated liquid effluent from

TABLE 2.—RADIOACTIVITY OF AIRBORNE PARTICULATES, FMPC

[Average concentrations in $\mu\mu c/m^3$]

Location	Second half 1961			First half 1962		
	Number of samples	Uranium[a]	Total activity[b]	Number of samples	Uranium[a]	Total activity[b]
On-site:						
Southwest	24	0.14	1.83	27	0.27	3.21
Northwest	25	0.14	1.79	27	0.08	2.95
Northeast	24	0.14	2.12	27	0.14	3.00
Southeast	23	0.13	1.38	27	0.16	2.81
All on-site samples	96	0.14	1.77	108	0.16	2.99
Off-site:						
0–2 miles from FMPC	25	0.07	0.32	5	0.09	2.24
2–4 miles from FMPC	22	0.04	0.22	2	0.12	2.11
4–8 miles from FMPC	11	0.02	0.65	4	0.03	1.66
8–10 miles from FMPC	9	0.02	0.56	3	0.03	1.17
All off-site samples	67	0.05	0.38	14	0.07	1.80

[a] Refer to table 1 line 11.
[b] Refer to table 1 line 7.

the production plants, water treatment plants waste effluent, storm sewer discharge, and treated sanitary sewage. Using the data from the combined sewage samples and stream flow data for the Great Miami River, the FMPC contribution to radioactivity concentrations in the river may be calculated. To check the calculated results, weekly upstream and downstream spot samples are taken. Table 3 presents a comparison of the calculated and the spot check river concentrations. Sampling points are shown in figure 2.

Previous coverage in *Radiological Health Data*:

Period	Issue
1959, First half 1960	*April 1961*
Second half 1960, annual summary 1960	*June 1961*
First and second quarters 1961	*December 1961*

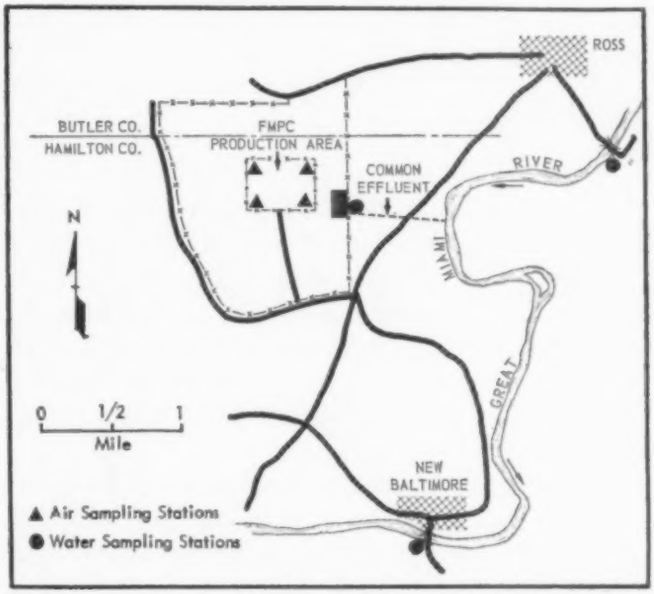

Figure 2.—AIR AND WATER SAMPLING STATIONS, FEED MATERIALS PRODUCTION CENTER

TABLE 3.—CONCENTRATIONS OF URANIUM AND TOTAL ACTIVITY IN THE GREAT MIAMI RIVER, OHIO

[Average concentrations in $\mu\mu c$/liter]

Location	Method of determination	Second half 1961			First half 1962		
		Number of samples	Uranium[a]	Total activity[b]	Number of samples	Uranium[a]	Total activity[b]
Sewer outfall	Calculated from sewer concentrations and stream data (continuous sampling).	184	8	12	181	5	6
Upstream	Spot samples	29	9	34	31	11	64
Downstream	Spot samples	29	10	39	31	11	66

[a] Refer to table 1 line 11.
[b] Refer to table 1 line 1.

MOUND LABORATORY

Monsanto Chemical Company
Miamisburg, Ohio

First Half 1962

During the first half of 1962 none of the radioactive materials used by Mound Laboratory (ML) contributed measurable penetrating radiation to the environment. Possible air contaminants were plutonium, polonium, and tritium; possible river water contaminants were polonium and tritium. The Laboratory uses as its guides the environmental MPC's as determined from NBS "Handbook 69" (see table 1).

Air Monitoring

A continuous air monitor for measurement of tritium and particulate air sampling equipment for measurement of alpha activity mounted on a one-ton panel truck are used in the routine monitoring of the environmental air at 95 locations selected within a radius of 20 miles. The choice of sites on a given day depends on the wind direction at the time of collection.

A total of 362 samples were taken for determination of tritium in air during the first half of 1962. In all cases the tritium concentrations were below detectable levels.

Monitoring for possible polonium and plutonium released to the environment is accomplished by determination of long-lived gross alpha on filter paper samples. Counting was done in a low-background proportional counter after sufficient time had elasped after collection to permit the decay of short-lived daughter products of radon and thoron. The measured concentrations of alpha activity in air are summarized in table 4. For purposes of comparison, upwind and downwind activities for the fourth quarter 1961 were 0.016 and 0.025 $\mu\mu c/m^3$, respectively.

Water Monitoring

Liquid radioactive waste materials from polonium work at the Laboratory are processed in a special waste disposal plant designed to reduce radioactivity to a concentration level at which it may be discharged to the Great Miami River (station 2 in figure 3). Liquid waste from the plutonium work is small in volume. It is handled separately as a packaged waste and is not discharged to the river. Helium–3, which is purified at the Mound Laboratory, yields small quantities of tritium. Liquid wastes from this work, also small in volume, are treated separately (diluted with water when necessary) to assure that the radioactive content i

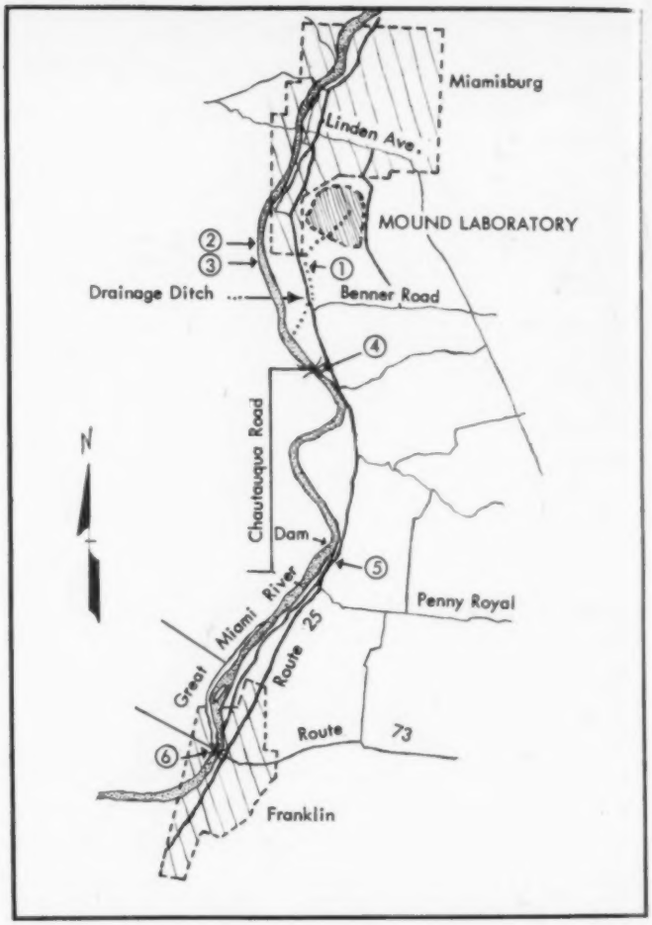

Figure 3.—WATER SAMPLING LOCATIONS IN GREAT MIAMI RIVER, MOUND LABORATORY

TABLE 4.—WIND EFFECT ON LONG-LIVED ALPHA CONCENTRATIONS IN AIR, ML, 1962

Direction from laboratory relative to wind	First quarter		Second quarter	
	Number of samples	Alpha [a] ($\mu\mu c/m^3$)	Number of samples	Alpha [a] ($\mu\mu c/m^3$)
Upwind	30	0.0033	17	0.0005
Downwind	178	0.0029	137	0.0014

[a] May be compared with table 1 lines 8 and 9.

below the maximum permissible concentration for discharge to the Great Miami River.

Weekly water samples are collected from a drainage ditch and five locations along the Great Miami River as shown in figure 3. The drainage ditch carries away all storm sewer water and liquid tritium wastes from the plant site. Sampling location number 2 is located at the point of discharge of the laboratory effluent to the Great Miami River. Number 6 is five miles downstream from the effluent discharge. Additional single downstream samples were collected at five locations (beyond the limits of the map in figure 3) during the first quarter.

All of the river samples are analyzed for polonium concentration. The drainage ditch samples and some of the river samples are analysed for tritium. Average concentrations of tritium are given in table 5.

Previous coverage in *Radiological Health Data*:

Period	Issue
1959 and first quarter 1960	*November 1960*
Second quarter 1960	*February 1961*
Third and fourth quarters 1960	*May 1961*
First and second quarters 1961	*January 1962*
Third and fourth quarters 1961	*June 1962*

TABLE 5.—OFF-SITE WATER MONITORING FOR POLONIUM AND TRITIUM, ML

[Average concentrations in $\mu\mu c$/liter]

Station code number (see figure 5)	First quarter 1962				Second quarter 1962			
	Tritium[a]		Polonium[b]		Tritium[a]		Polonium[b]	
	Number of Samples	Concentration	Number of Samples	Concentration	Number of Samples	Concentration	Number of Samples	Concentration
1	9	70,000	0	—	11	50,000	0	—
2[c]	9	40,000	9	0.40	9	30,000	9	15.7
3	0	—	8	0.22	0	—	11	0.63
4	8	13,000	8	0.45	11	40,000	11	0.32
5	0	—	9	0.20	0	—	11	4.95
6	0	—	9	0.40	0	—	11	0.63
Others[d]	0	—	0	—	0	—	6	0.6

[a] Refer to table 1 line 10.
[b] Refer to table 1 line 9.
[c] Station 2 is Mound Laboratory effluent.
[d] Single samples are semiannually collected at six downstream locations between Franklin and Elizabethtown, Ohio.

Reported Nuclear Detonations
FEBRUARY 1963

During the past two months, two announcements of nuclear detonations were made by the Atomic Energy Commission. Both announcements were for detonations taking place in February. The first announcement reported the resumption of underground testing on February 8 at the Nevada Test Site, but the total number of detonations was not indicated; therefore, in the tabulation below, the numbering arbitrarily shows one test on that date.

Two detonations were announced on February 21, one of which was described as a weapons development test and the other was identified with the "Plowshare" series of tests involving peaceful uses of nuclear exposives.

TABLE 1.—SUMMARY OF NUCLEAR DETONATIONS REPORTED DURING FEBRUARY 1963

Test number	Location	Date	Yield range [a]	Type of Test
[b] 98	Nevada Test Site	February 8	"Intermediate or less"	Underground
99	Nevada Test Site	February 21	Low	Underground
[c] 100	Nevada Test Site	February 21	Low	Underground

[a] Low yield range has been announced as less than 20 kilotons yield; intermediate yield is in the range of 20 kilotons up to 1 megaton; and low megaton yield is in the range from 1 to several megatons.
[b] Unspecified number of tests were conducted on this date.
[c] Third "Plowshare" Program test reported in *Radiological Health Data* since the tabulation was started in the fall of 1961.

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UNITS AND EQUIVALENTS

For the convenience of the *Radiological Health Data* (*RHD*) reader a selected list of units and equivalents is presented below.

Symbol	Name	Equivalent
Bev	billion electron volts	
cpm	count per minute	
dpm	disintegration per minute	
g	gram	
kg	kilogram	1 kg = 1000 gm = 2.2 pounds
km^2	square kilometer	
kvp	kilovolt peak	
m^3	cubic meter	1 m^3 = 1000 liters
ma	milliampere	
mas	milliampere-second	
Mev	million electron volts	
mi^2	square mile	
ml	milliliter	
mm	millimeter	precipitation: $\text{mm} = \frac{\text{m}\mu\text{c/m}^2}{\mu\text{c/liter}} \times 1000 = \frac{\text{liter}}{\text{m}^2}$
mrad	millirad	
mrem	millirem	
mr/hr	milliroentgen per hour	
mμc	millimicrocurie	1 mμc = 1 nc
nc	nanocurie	1 nc = 1000 pc = 1 mμc = 10^{-9} curies
nc/m^2	nanocurie per square meter	1 nc/m^2 = 1 $m\mu c/m^2$ = 1,000 $\mu c/m^2$ = 1 mc/km^2 = 2.59 mc/mi^2
pc	picocurie	1 pc = 1 μc = 10^{-12} curies
r	roentgen	
μc	micromicrocurie	1 μc = 2.22 dpm

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